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THE RÔLE OF FITNESS IN EVOLUTION

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Fitness, though so frequently referred to by selectionists, and a term of so much importance in their theory, nevertheless lacks definite meaning. Referring to ability to survive, its only proof under the theory is survival. This has been pointed out by various authors among whom we may quote Lloyd, "Fitness is not a reality in itself, it is only a term used to express the fact of survival." (8, 180.)

Those accustomed to look the least below the surface cannot accept this illogicality. They can, moreover, readily point out its falsity. Does not a forest fire, a flood, any sudden and overwhelming catastrophe, take lives without regard to individual qualifications? Many of the creatures destroyed must have been fit, in any reasonable sense of the word, but they did not survive.

The same thing is obvious in the case of mass eliminations by year classes among fishes, oysters, and coniferous seeds, for example. When all are eliminated the reason cannot be unfitness; and this is true also of the normal going under of a very high percentage of the individuals of any organism having large numbers of young. When 99% or more of the individuals are eliminated all cannot be unfit.

Fitness as the sole reason for survival and survival as the sole evidence of fitness are fruits of a type of philosophy that surely has run its course. If there is nothing of more real worth in the doctrine of the "survival of the fittest," the sooner it is abandoned, the better.

The selectionist idea of fitness being an impossible one, let us consider what is ordinarily meant by the term. Does it not merely mean apparent health as evidenced by good appearance, alertness, and vivacity? Is it not based on such qualifications as sound bodily condition, tissue tone, and good co-ordination?

Further, are not all these things largely of individual development?

INDIVIDUAL DEVELOPMENT OF FITNESS

The almost universal practice of athletics by those whose vocation does not involve sufficient bodily activity is acknowledgment by the human race that fitness must be individually acquired and maintained. The pitiful lack of development of children who have been closely confined is sad evidence on the negative side.

Breeders of animals know that if the young are not adequately fed and exercised and kept steadily progressing throughout the formative period they will never attain normal size and development.

The conditions of captivity profoundly affect animals and rearing in confinement prevents development of the fitness we observe in wild individuals of the same species. As to game birds an authority says:

"No birds that are kept in captivity and hand-fed are as sporty to shoot, or have the same flavor when eaten, as birds either raised in the wild state or put out at an early age to rustle for themselves. Birds liberated young soon become strong on the wing, and assimilate the craft of their forbears. The wild feed they subsist on, in addition to the planted grain, actually gives them a wild flavor when eaten. Thus, in a few weeks, they practically assume the status of wild birds. On the other hand, birds reared in captivity and placed in the coverts at maturity, and probably at the most not more than a week or two before they are shot, lack the above characteristics to a great extent, although the loss will be much less. They will probably be fatter, and therefore slower on the wing for this reason, as well as because of lack of exercise. In the case of pheasants, they are apt to run more, and not rise with the snap that characterizes the wild bird. Quail also act sluggish, and I have seen covies sneaking along through the grass, loath to rise until actually put up." (Smith, 10, 21–22.)

The differences in captive bred animals may extend even to deep-seated structural characters as those of the skeleton. For instance, Hollister shows that in captive lions "Changes in the skull which would be accepted as of 'specific' or possibly of 'generic' value in wild animals from different regions are thus produced in the life of a single individual." (7, 190.)

The following frequently quoted instance is of interest in this connection. "Some of our countrymen [Englishmen] engaged about the year 1825, in conducting one of the principal mining associations in Mexico, that of Real de Monte, carried out with them some English greyhounds of the best breed, to hunt the hares which abound in that country. * * * the scene of sport is at an elevation of about 9,000 feet above the level of the sea, and the mercury in the barometer stands habitually at the height of about 19 inches. It was found that the greyhounds could not support the fatigues of a long chase in this attenuated atmosphere, and before they could come up with their prey, they lay down gasping for breath; but these animals have produced whelps which have grown up, and are not in the least degree incommoded by want of density in the air, but run down the hares with as much ease as the fleetest of their race in this country." (Lyell, 9, 2, 297.)

We see in such cases the effect of environment and of the activities of the animal in the environment. We see that inheritance does not rule, that organisms will not develop their normal characteristics unless normally environed and exercised. We therefore conclude that fitness which above all things is of individual acquisition, is not inherited. Further testimony to this effect is given in the following section.

FITNESS NOT INHERITED

In sexually propagated organisms, all individual qualifications have to be developed from the egg anew. There is no direct transmission of them from adult to adult. As Hogben states the case for the human race, "Our parents do not endow us with characters. They endow us with genes." (6, 11.)

Further comment by authors along this line are quoted here.

"It is certain that in the past we have too readily assumed that characters which appear in successive generations are transmitted by heredity, and we have given too little attention to the possibility of their being acquired independently by each generation." (Conn, 3, 357.)

"Many characters of adult organisms consist in part of a genetic or hereditary contribution, which might be called a qualitative element, to which is added during growth a quantitative reaction to more or less favorable conditions, depending not only upon external circumstances but also upon the perfection and efficiency of the remainder of the organism." (Cook, 4, 255.)

"Individuals having the same hereditary composition may show very diverse characteristics in different environments." (Coe, 2, 111.)

"That many individuals of the species are distinctly ill adapted to their environment is a common observation, but this usually results from the failure of the individual to realize the full advantage of his heritage." (Coe, 2, 112.)

"An organism's qualities, characters, are the result of its development, as such they cannot be said to be inherited." (Hagedoorn, 5, 11.)

"It cannot be emphasized too strongly that the individual as we know him at any moment is the resultant of the hereditary qualities he possesses as developed by the particular environment in which he has lived." (Thompson, 11, 338.)

"Heredity does not account for the individual, but merely for the potentialities some of which are realized in the individual. In other words, the internal and transmitted factors are by themselves unable to 'produce' an animal at all. The same point of view has been developed by Goodrich, who stresses the distinction which has to be drawn between the process of transmission of the internal factors from parent to offspring, and the process of production in the offspring of characters similar to those which were possessed by the parent. 'An organism is moulded as the result of the interaction between the conditions or stimuli which make up its environment and the factors of inheritance. No single part is completely acquired, or due to inheritance alone. Characters are due to responses and have to be made anew at every generation.' Similar views have been expressed by Conklin." (de Beer, 1, 14–15.)

CONCLUSION

Instead of organisms living longest because they are fittest it is apparent that they may develop more and more fitness the longer they live (senile deterioration excepted). Fitness is distinctly a qualification that must be individually acquired, and is only fully developed by normal activity in a normal environment. It is not inherited nor can it be transmitted. Under this view it loses most of its importance for the theory of natural selection. The "survival of the fittest" is of no moment if fitness is not inherited.

Since the germinal constitution is probably not defective in the bulk of a population, it follows that almost any individuals of average fitness (capable of conjugation) would serve equally well as progenitors of the race. Since as a rule such ordinary individuals do in fact survive and reproduce their kind we must conclude that the role of the "fittest" in the organic world is not at all that attributed to it by the theory of "natural selection."

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Statistical Analysis

"Methods of Statistical Analysis," by C. H. Goulden, has been prepared on the assumption that a thorough knowledge of statistical methods, as applied to research problems, can be obtained best by actual practice in the application to field and laboratory experiments. It gives the theory and practice of statistical methods in a simple manner using a series of well graded examples for demonstration. It stresses throughout the logical development of the subject and the necessity for the use of exact methods. The text moves rapidly through the fundamentals, dealing with the "small sample technique and correlation in the early chapters. The main object of the book is to bring together a working knowledge of the concepts used in the analysis of variance. Over half the text is given to an elaboration of this technique. Each chapter has a series of carefully selected exercises with the raw data from which they can be worked.

The appendix gives G. W. Snedecor's table of "F and t," which is an excellent aid in directly checking significant probabilities in either simple problems or in any elaboration following analysis of variance.—R. G. SCHOTT.

Methods of Statistical Analysis, by C. H. Goulden. 165 pp. Minneapolis, The Burgess Publishing Co., 1936. $3.00.

THE POSTULATED RESEMBLANCE OF NATURAL TO ARTIFICIAL SELECTION

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"*A parallelism that does not exist.*"—HERBERT SPENCER (18, 440).

INTRODUCTION

Much of Darwin's book, "The Origin of Species by Means of Natural Selection" and most of his larger work, "The Variation of Animals and Plants under Domestication," is devoted to exposition of his postulate that "natural selection" is a process comparable to that exercised by man on domesticated animals and plants. A few quotations will illustrate the point.

"The term [natural selection] is so far a good one as it brings into connection the production of domestic races by man's power of selection and the natural preservation of varieties and species in a state of nature." (7, 1, 6.)

"The principle of natural selection may be looked at as a mere hypothesis but rendered to some degree probable by what we positively know of the struggle for existence, and the consequent almost inevitable preservation of favourable variations, and from the analogical formation of domestic races." (7, 1, 9.)

"As man can produce, and certainly has produced, a great result by his * * * selection, what may not natural selection effect?" (6, 72.)

In any discussion much depends on what is meant by the basic terms involved. Let Darwin's own definitions, therefore, prevail. As to natural selection, he says, "Can we doubt * * * that individuals having any advantage, however slight, over others, would have the best chance of surviving and procreating their kind? On the other hand, we may feel sure that any variation in the least degree injurious would be rigidly destroyed. The preservation of favorable individual differences and variations, and the destruction of those which are injurious, I have called Natural Selection, or the Survival of the Fittest." (6, 70.)

As to artificial selection, he says, "We cannot suppose that all the breeds were suddenly produced as perfect and as useful as

we now see them; indeed in many cases we know that this has not been their history. The key is man's power of accumulative selection; nature gives successive variations; man adds them up in certain directions useful to him. In this sense he may be said to have made for himself useful breeds." (6, 25.)

Some rather fundamental differences between artificial selection and the biological events dubbed "natural selection" are obvious on first consideration. For instance, in the artificial process there is always, in the natural, never, a conscious selector; in the former, selection is for the benefit of the selector, in the latter it is supposed to benefit the selected; man makes conditions as favorable as possible for the organisms under his selection; Nature, Darwinians inform us, always puts hers through a merciless struggle for existence. These and other contrasts between artificial and natural selection will be more fully discussed under separate headings.

SELECTORS

In artificial selection there is always conscious human choice directed toward definite ends, toward something more than mere maintenance of the existence of races. In nature there is elimination, there is death, but no selector, nor anything comparable to one; consequently there are no definite ends, no objects in view, beyond keeping "seed alive upon the face of the earth." On the other hand, human effort may be directed for generations to the same end as, for instance, increase of speed in horses, milk yield in dairy cattle, or egg production in fowls. In nature the so-called selection by elimination may at one time be the result of climatic severity, at another of disease, again of depredations by enemies, and so on; the number of eliminating agents may be almost infinite. There can be no continuity of development along particular lines as the result of elimination for an infinity of reasons. The fact that steady evolutionary progress is known only goes to show that factors other than those causing elimination are in control.

Writing of artificial selection, Darwin says, "As each new variety is produced, the earlier, intermediate, and less valuable forms will be neglected and perish." (7, II, 231.) By contrast it must be pointed out that in nature where there are no conscious selectors, there will be no judgment as to less valuable forms, and no power to neglect.

FOR WHOSE GOOD?

Darwin admits the contrast between artificial and natural selection as to beneficiaries. "It is not surprising," he states, "that domestic races should generally present a different aspect from natural species. Man selects and propagates modifications solely for his own use or fancy and not for the creature's own good." (7, II, 232.)

In the "Origin of Species" he further says, "Man selects only for his own good; nature only for that of the being which she tends." (6, 72.) No comment would seem to be necessary in certifying as to this distinction between artificial and natural selection.

FITNESS

Artificial selection need scarcely be concerned with the utility of a character to the organism, or even indeed of the general fitness of the latter, while in natural selection, according to theory, utility of characters and general fitness are the ruling factors. This point also is conceded by Darwin, who says:

"It is obvious that a host of artificial races could never survive in a state of nature;—such as Italian greyhounds,—hairless and almost toothless Turkish dogs,—fantail pigeons, which cannot fly well against a strong wind,—barbs and Polish fowls, with their vision impeded by their eye wattles and great topknots,—hornless bulls and rams, which consequently cannot cope with other males, and thus have a poor chance of leaving offspring,—seedless plants, and many other such cases," (7, II, 212), and adds, "Our wonderfully improved pigs could never have been formed if they had been forced to search for their own food." (7, II, 220.) He further states: "With animals and plants reared by man there is no severe or recurrent struggle for existence." (7, II, 309.) Like most voluminous writers, however, Darwin makes some more or less contradictory remarks, one bearing on the present topic being, "With our domesticated animals natural selection checks the production of races with any injurious deviation of structure." (7, II, 420.) In view of swine that can hardly waddle; ducks, geese, and chickens that cannot fly; dogs, chickens, pigeons with impeded vision, etc., this remark can scarcely be taken seriously. The keeping of many such domesticated animals in defensive enclosures, and canaries and other cage-bred birds constantly in cages is eloquent admission that they do have

injurious deviations of structure and are unfit for life in the open. Evidently they have not been selected for fitness.

In artificial selection a considerable fault may be overlooked if a very desirable virtue is present. In natural selection (as defined) elimination for the fault would proceed, no account being taken of the virtue. Artificial selection as a rule degrades organisms in point of fitness so far as ability to survive in the wild is concerned. Natural selection if it acts as claimed must do the very opposite. It is difficult to trace any similarity of the two processes in relation to fitness.

STRUGGLE FOR EXISTENCE

The conception of a severe struggle for existence is in reality antithetical, rather than contributory, to the ideal of the survival of the fittest. J. W. Dawson pointed this out clearly when reviewing Darwin's "Origin of Species" in 1860. "We have been told very truly," he says, "that the reason the wealthy and skillful breeder succeeds in producing marked races is that his animals are cared for and pampered, while the savage and the poor man fail because their animals must struggle for subsistence. Nature it appears takes the opposite way, and improves her breeds by putting them through a course of toil and starvation, a struggle not for happiness or subsistence, but for bare existence. We can understand how this should deteriorate and degrade species, as we know it has done in every case of the kind we have observed; but how it should elevate or improve is past comprehension. But does Nature deserve to be charged with such niggardliness, and with so concealing it that all the world seems to be full of happiness and plenty, except where poor man toils on in his poverty?" (81, 112.)

Man's selection is of individuals to live and be given the most favorable treatment practicable, while nature's is of those doomed to die, the survivors according to theory being those that have passed through a struggle for existence so severe as to kill off all but a small proportion of the total number of offspring. Man pampers, and improves his selections; Nature's process as pictured by the Darwinian theory could only leave broken and enfeebled remnants in no wise entitled to be called the fittest. The fact that most creatures under natural conditions are sound and in good condition is proof that they have not been subjected to a ruthless struggle for existence. The

death of some, the escape of others apparently unscathed, very clearly shows the workings of a process akin to chance rather than one of selection.

ELIMINATION OF YOUNG

Wholesale destruction of immature stages is the rule in nature. "Selection," if it can be so termed, occurs chiefly before the adult characters, those upon which continuance of the race depends, are developed. Except in highly polygamous species a large proportion of those attaining maturity participate more or less in the reproduction of the species. The plant or animal breeder, on the other hand, must rear his material until adult characters are apparent, and in his most effective operations, until ability to transmit desirable qualities is tested. The process is quite distinct from what does or can occur in nature.

PROGENY PERFORMANCE

The term "prepotency," old in breeder's language, signifies marked power to transmit likeness. Darwin remarked, "The subject of prepotency is extremely intricate * * * no one has hitherto succeeded in drawing up general rules on the subject." (7, II, 47.) In their attempts to utilize prepotency pioneer breeders were groping for a tool which later has been firmly grasped and recognized as the most effective at the breeder's command. It is the progeny test.

"The term progeny test as applied to animal breeding, refers to the estimation of an individual's value as a breeder by means of the qualities or performance of its offspring. The earlier practice was to judge an individual by its ancestors as indicated by its pedigree, but more recently the situation has been reversed and now the individual breeding bird [fowl] is judged by its offspring." (Warren, 20, 3–4.)

"The foregoing discussion indicates that the only dependable measure of a bird's breeding value is the progeny test. If this be true, the question then arises as to what value the pedigree has. In reality the pedigree does not have the value placed upon it by many animal breeders. It supplies some history of the performance of a bird's ancestry, but gives no assurance that the same qualities will be transmitted by this bird to its offspring." (Warren, 20, 19.)

"The mean egg production of the daughters of the mating

of a given sire and a given dam is the index of greatest value in determining the breeding potentiality of an individual sire or dam." (Jull, 14, 513.)

"The idea of rating bulls by the progeny test is not new. Such historic livestock improvers as Bakewell and Cruickshank are known to have hired out bulls to their neighbours, bringing them back into their own herds again if they proved themselves by their progeny. The underlying principles of the progeny test are sound genetically. It is the aim of the scientific breeder to assess the transmitting abilities of his stock and, as has been mentioned, this is scarcely ever possible to a sufficient degree in the case of the female, although more often available in the case of the male with his large number of offspring. With ten daughters to a bull out of ten different dams, there are ten indications of the transmitting abilities of the bull, against only one of each individual dam. In the process of proving a bull it is obviously of primary importance that all his daughters be considered—that there be no selection. Systems which allow of the practice of testing only the best daughters or of considering a bull proved when he has a fixed number of daughters exceeding an arbitrary level of production are very inadequate. Information on the numbers and performances of low producers is as valuable as it is on the high producers." (Edwards, 9, 820.)

"Selection has as its objective the identification and propagation of those superior individuals which are believed to be capable of reproducing their good qualities in their offspring. Here the progeny test becomes extremely valuable, for by its aid—and I think no one will question its indispensability—it is possible to obtain a reading of each breeder's worth and thus recognize those individuals that should be continued in active service as well as the best manner of mating them in the future." (Goodale, 11, 486.)

"Improvement is next to—if not actually—impossible when bulls are selected for breeding at random, which is what selection without a progeny test amounts to." (Goodale, 11, 496.)

"Practically everywhere, the plant-breeders have abandoned their selection according to individual merit * * * and resorted to some system of judging plants after their progeny." (Hagedoorn, 13, 191.)

"Repeated attempts by plant breeders, working with different species of both self-fertilized and cross-fertilized crops,

have failed to discover any sound basis for selection of parent plants except that which involves a progeny test." (Kirk, 15, 515.)

"Any of the progeny tests are better than selection on type and pedigree only." (Warwick & Copeland, 21, 181.)

From these positive statements of a number of modern authorities, it seems unquestioned that the progeny test is the most effective basis for selection available to either plant or animal breeders. It is obvious without discussion that the method can have no part in "natural selection."

PEDIGREE BREEDING

While the progeny test looks towards the qualities of offspring, pedigree breeding pays most attention to those of ancestors. This method, while still used, was of greater importance in times prior to widespread recognition of the value of the progeny test. It was, however, and still is an important part of artificial selection but of course cannot occur in nature.

COMMENT IN BRIEF, MOSTLY FROM OTHER AUTHORS

The usual fertility of domestic races when crossed is in strong contrast to the usual mutual infertility of natural species.

Races created by artificial selection, left to themselves, tend to revert to the original type. Natural species tend to continue as they are.

In artificial selection the old form may be preserved alongside the new. In natural selection the new is supposed to supplant the old.

The changes in natural evolution seem to be characteristically slow while very striking changes have been produced in a few years by artificial selection.

"Natural selection is not a force like that of the breeder who looks over his animals and selects some few that have a given character especially developed. The word 'selection' is here misleading. There is in nature no selector and no selecting. Nature does not select the best, but simply eliminates the worst. There is a great difference between a process that consciously picks out the best and one that unconsciously eliminates the worst." (Conn, 3, 70.)

"Under unconscious or natural selection only the most deficient of these characters are rejected; under conscious or

artificial selection by man only the most proficient are saved." (Cook, 4, 279.)

"Domestication * * * shows us only the conditions in which constructive evolution does not take place, even in nature." (Cook, 4, 361.)

"While artificial selection involves intelligent choice in the destruction of superfluous individuals, natural selection, * * * is non-selective. It involves destruction but not construction." (Cuénot fide Gerould, 10, 121.)

Artificial selection proceeds under environmental conditions that are made uniform as possible; "the external environment when natural selection occurs is exceedingly complex." (Bucholz, 1, 278.)

"Artificial selection sets a uniform standard of excellence of performance for all participants," (Bucholz, 1, 279); in "natural selection" this is rendered impossible by the great diversity of environment.

While it will not be admitted by staunch selectionists, elimination in nature (or "natural selection") is very indiscriminate. "In fact so complex is the environment * * * that accident and chance really play a major role." (Bucholz, 1, 279.) In artificial selection, on the contrary, individuals in the least undesirable may be rigidly eliminated.

"Where, as in nature, the variable offspring of an occasional cross goes under into the multitude, under cultivation aberrant individuals are apt to be noticed and given a chance to show their value. Under cultivation both processes in evolution, on one hand heightening of variability by crossing, and on the other hand reduction of variability by isolation, selection and colonization are exaggerated far beyond anything we can ever hope to find in nature. Propagation of plants and animals under domestication is essentially different from propagation in nature, as the former is essentially a continued system of colonization." (Hagedoorn, 13, 231.)

"Man introduces animals into new conditions, teaches them new habits, or develops old habits, and the inevitable consequence is, that a considerable change takes place which transmutes species quite apart from any selective influences." (Coe, 2, 132.)

"Natural Selection, which is supposed to dominate nature and largely to direct the transmutation of species, must act, if it acts at all, under disabilities which would make all the

efforts of Artificial Selection futile, and yet the experiment of Artificial Selection is cited as the most convincing proof of the reality of * * * (Natural) Selection. * * * No practical man would think of adopting the method which is supposed to take place in nature, because he knows that it would be a complete failure." (Coe, 2, 155, 156.)

"The essential factors which have been involved in the production of our best fruits, grains, vegetables, flowers, etc., have been (1) the improved conditions of domestication, (2) mutations, leading at once to new and better forms, (3) hybridization, which by new combinations of characters and as a result of heterosis has led to amelioration, and (4) the purification of previously mixed races or varieties by selective sorting. It is to the overwhelming importance of one or a combination of these factors that the 'experience of breeders' points and not to Darwinian selection." (Pearl, 17, 81.)

SUMMARY

There are enumerated in previous pages some fifteen to twenty differences between the processes of artificial and "natural" selection, and these are not all that have been pointed out in the literature. In several respects the two processes are diametrically opposite in character. Some of the most effective factors in artificial selection as pampering, conscious choice, and preservation on the ground of ancestral pedigree or progeny performance cannot possibly be a part of "natural selection."

On the other hand, the intensity of elimination of the immature, the rigid destruction of variations "in the least degree injurious," the severity of the struggle for existence, reducing every generation, whatever its increase, back to its original numbers, features which by hypothesis, or in fact characterize "natural selection," are quite different from the processes of artificial selection.

Darwin tried to show how "natural selection" is similar to the art of breeders, but if he had ever contemplated the matter in reverse he would have realized that the methods he attributes to Nature are not imitated by man, and that if they were the achievements of artificial selection would have been quite impossible.

To those fond of equations it may seem elementary to say that if a = b, then b = a. Even so elementary a test, however, has not been applied by selectionists to the dogma discussed

in this paper. If "natural selection" is similar or analogous ("precisely analogous" according to Romanes) to artificial selection, then artificial selection should be similar or analogous to "natural selection."

For variety's sake let us turn to the Encyclopaedia Brittanica for definitions. There we learn that in artificial selection "the choice of the individual for further breeding is determined by (1) its appearance, (2) the record of its ancestry (pedigree) and (3) the record of its progeny (the progeny test)." (Crew, 5, 296.) All of these criteria can operate only through conscious choice and the second and third of them must have the aid of records. Surely only a hardy spirit can believe that anything at all comparable exists in nature.

As to "natural selection," we read, "according to Darwin, then, the chief factors which contribute to the process of evolution are variation, heredity, and the struggle for existence. To their combined action he gave the name 'natural selection' in analogy with the similar process carried out by man on domestic plants and animals." (Goodrich, 12, 920.) Since variation and heredity must be considered as of more or less the same value whether in the artificial or the natural process, it is apparent that everything depends on the meaning of "the struggle for existence"—Nature's "selecting" device. Extracting briefly from the definition of this struggle it appears that, "There is a perpetual competition for space, food, and all necessaries of life. * * * If one [species] increases it must be at the expense of some other. * * * on the average only two individuals can survive to replace the parents out of the whole number of offspring. As a rule the greatest destruction takes place when the organisms are quite young. * * * Just as the intensity of the struggle may be measured by the death rate, so a variation is advantageous in so far as it lowers this rate; and this gives a measure of its 'selection value'." (Goodrich, 12, 923.)

We see nothing here of special care, or of conscious choice, of pedigree breeding, or of progeny testing, the whole of artificial selection; we see instead a formidable array of destructive processes all of which so far as possible are excluded from artificial selection.

If belief in "natural selection" depends on its analogy to artificial selection then that belief can scarcely prevail.

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PANGONIINAE OF UTAH (TABANIDAE: DIPTERA[1])

J. A. ROWE AND G. F. KNOWLTON[2]

The abundance, the blood-sucking habits, the annoyance to livestock and man, and the actual and potential ability to transmit disease makes the family Tabanidae of particular importance in Utah. Studies of insect transmission of equine encephalomyelitis, conducted at the Utah Agricultural Experiment Station, and the need for more ready recognition of the species in the field, has led to the present treatment.

The writers are indebted: To Dr. V. M. Tanner, Brigham Young University, Provo, Utah, for so generously lending material; and to Dr. C. B. Philip, of the U. S. Public Health Service, and Dr. A. Stone, of the U. S. Bureau of Entomology and Plant Quarantine, for helpful suggestions and identifications.

The Pangoniinae are horseflies which bear apical spurs on the hind tibiae.

KEY TO GENERA

1. Eyes distinctly pubescent.....**Osca** Walker
   Eyes bare..... 2
2. Third segment of antennae with at least seven annuli, front of female much wider below than above.....**Apatolestes** Williston
   Third segment of antennae with not more than five annuli, front of female almost parallel-sided..... 3
3. Second segment of antennae only half as long as the first, eyes in life with many small dots.....**Silvius** Meigen
   Second segment of antennae as long or nearly as long as the first, wings with dark pictures.....**Chrysops** Meigen

Osca californica (Big.)

Diatomineura californica Bigot, Mem. Soc. Zool. France, 5: 618. 1892.
Pangonia dives Will., Kan. Acad. Sci., 10: 130. 1886.

Characteristics—Large and robust; general color yellow; each abdominal tergite with anterior half brown or black and posterior half yellow; male more pilose than female, with the black of the abdomen often in the form of a median row of spots; antennae reddish-yellow, annulate portion black.

Habitat—Logan, Brigham, Farmington, Salt Lake City.

Hine (1904) declared the synonomy of *D. californica* Big. (1892), with *P. dives* Will. 1887; however, there is an earlier *P. dives* Macquart (1857), and by reason of this preoccupation Bigot's name should stand.

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[1]Contribution from the Department of Entomology, Utah Agricultural Experiment Station.

[2]Co-authors: Graduate Research Assistant and Associate Entomologist, respectively. Publication authorized by Director.

This species has been referred to various genera including *Buplex* Aust., *Scaptia* Walk., and *Osca* Walk. Because of the pubescence of the eyes it should not be referred to *Buplex*. Major Austen of the British Museum has compared it with *Pangonia patula* Walk. and *P. crassa* Walk., both of which were referred to *Scaptia* by Walker; it is Austen's opinion that this species is not referable to *Scaptia* but to *Osca*. Following Hine (1920, 1925), this species would be referred to as *Osca* Walk.

Apatolestes comastes Will.

Williston, Entom. Americana, 1: 12. 1885

This genus and species is not represented in our collection, but the close proximity of its range to Utah warrants mention here. The front of the female is much wider below than above and nearly entirely shining black.

Habitat—California, Arizona.

Genus **Silvius** Meigen

Meigen, Syst. Beschr. Zweifl. Ins., 2: 27. 1820

Hind tibiae with spurs at tip; first posterior cell open; ocelli present, wings usually with isolated spots and a rather large stigmal spot; eyes bare or with few short, scattered hairs; third segment of antennae composed of five annuli, the first much longer than those following, second segment of antennae half as long as first; type, *Tabanus vituli* Fabr.

KEY TO SPECIES

1. Wing with no black spots, body yellowish.....**gigantulus**
   Wing with black spots, body silvery..... 2
2. Dorsum of thorax with blackish stripes, abdomen with four distinct rows of black spots.....**quadrivittatus**
   Dorsum of thorax without blackish stripes, abdomen with two rows of black spots or none.....**pollinosus**

Silvius quadrivittatus (Say)

Say, Jour. Acad. Sci., Phil., 3: 33. 1923. (*Chrysops*), near Rocky Mountains

Characteristics—The key will serve to separate this species.

Habitat—Ft. Duchesne, Salina, Bluff, Zion National Park, and Santa Clara.

Silvius gigantulus (Loew)

Loew, Cent., 10: 12 (*Chrysops*), California

This species is not represented in our collection, but its extensive western distribution indicates that it probably occurs within the state. The wings are hyaline and without spots and yellowish along the costa; body yellowish; antennae yellowish, with the greater part of third segment brown; face with two small spots in triangular frontal callosity and ocelli dark brown; remainder of head and thorax yellow pollinose, with yellow pile.

Habitat—Vancouver Island, Washington, Colorado, California, Idaho, and New Mexico.

Silvius pollinosus Will.

Williston, Conn. Acad. Sci., 4: 244. 1880
Williston, Kans. Acad. Sci., 10: 131 (Western Kansas), 1886

Published records for Utah (Knowlton, 1931, 1934), from Ft. Duchesne (June 2, 1926) (W. Sorenson) may have been given from a misidentified *S. quadvivittatus*. This species is not represented in our collection and it is doubtful if it occurs in the state. It differs from *S. quadrivittatus* in having the wings more whitish; dorsum of abdomen with two rows of black spots or none; no black stripes on the dorsum of the thorax.

Genus **Chrysops** Meigen

Meigen, Illiger's Mag., 2: 267. 1803
Meigen, Syst. Beschr., 2: 50. 1820

Characteristics—Eyes bare or with few short, scattered hairs, with irregular green patches in life; ocelli present; wings with dark connected pictures, first posterior cell open; hind tibiae with spurs at the tip (sometimes small); third antennal composed of five annuli, the first much longer than the succeeding ones; second antennal more than half as long, or equal to, the third; type, *Tabanus caecutiens* Linn.

KEY TO SPECIES

1. Apex of the wing beyond the cross-band entirely hyaline or with the marginal cell slightly dusky 2
   Apex of the wing beyond the cross-band not entirely hyaline, usually with a prominent apical dark cloud extending at least into the submarginal cell 4
2. Abdomen with greater part of first two segments yellow (Fig. 2) ..... **excitans**
   Abdomen with first two segments black 3
3. Base of fifth posterior cell hyaline, anal and axillary cells entirely hyaline (Fig. 5) ..... **carbonarius**
   Base of fifth posterior cell dark, anal and axillary cells smoky along the sixth long vein (Fig. 11) ..... **mitis**
4. First antennal segment distinctly dilated 5
   First antennal segment not dilated 7
5. Hyaline triangle of wing separated from the posterior margin of the wing (Fig. 13) ..... **fulvaster**
   Hyaline triangle reaching posterior margin of wing 6
6. Wing with hyaline spots in the first submarginal, discal and fourth posterior cells (Fig. 8). Callosities of head and first antennal segment extremely dilated (Fig. 14) ..... **dilatus** n. sp.
   Wing with the above cells entirely infuscated (Fig. 9). Callosities of the head and first antennal segment moderately dilated ..... **coquillettii**
7. Wings with a hyaline spot in the discal cell (Fig. 10). Abdomen yellowish with four rows of black spots ..... **discalis**
   Wings with discal cell infuscated 8
8. Abdomen entirely black, apical spot of the wing separated from the cross-band (Fig. 12) ..... **noctifer**
   Abdomen bicolored, apical spot of wing connected to cross-band 9
9. Second segment of abdomen with a black spot on the sides (Fig. 4). Wings with the apical spot narrow, confined to the costal border (Fig. 7) ..... **aestuans**
   Second abdominal segment yellow on the sides (Fig. 3). Apical spot not confined to costal margin ..... **lupus**

Chrysops aestuans v. d. Wulp

C. moerens Walker, List., 1: 201. 1848.
C. aestuans v. d. W. Tijdsch. Vor Ent., 10: 135. 1867.

Characteristics—Abdomen black beyond second tergite, with a median row of prominent gray triangles; second tergite with two lateral black triangles (these often not entirely isolated in the male); wings with the apical spot confined to the costal margin.

Habitat—Logan, Locomotive Springs, Penrose, Corinne, Utah; Paris, Idaho. This species is quite common, often taken with *C. fulvaster* but less abundant. The synonomy is by C. B. Philip, 1931.

Chrysops carbonarius Walker

Walker, List, I: 203. London. 1848
Hine, Ohio Nat., 5: 220. 1904
Philip, Minn. Agr. Exp. Sta. Tech Bul. 80: 84. 1931

Characteristics—Abdomen uniformly black; wings beyond cross-band hyaline; base of fifth posterior cell hyaline.

Hine (1904) has given the synonyms of this species as worked out by Osten Sacken and Miss Ricardo as *C. niger* Walk. (not Macq.), *C. provocans* Walk., *C. atru* Macq., *C. fugaz* O. S. The Aldrich catalog (1905) lists *C. carbonarius* Walk. as variety B. of *C. niger* Macq.; *Chrysops niger* Macq. has not been taken from this state, but we have a specimen from Ohio which differs greatly from our *C. carbonarius* Walk. The writers are of the opinion that both should be considered as valid species. *C. carbonarius* can be distinguished from *C. mitis* by the hyaline base of the fifth posterior cell and by the hyaline character of the anal cell and axillary lobe.

Habitat—Plain City, Sheep Creek (Duchesne Co.).

Chrysops coquillettii Hine

Hine, Ohio Nat., 5: 220. 1904

Characteristics—First segment of antennae dilated; second tergite yellow with a median, geminate black spot; wings of female as shown in Figure 9.

Habitat—Zion National Park and Glendale.

Chrysops dilatus n. sp.

Female—Length, 7 mm.; occiput yellowish-gray pollinose; ocellar area polished black, quite small; frontal callus very prominent, somewhat tri-lobed when viewed from behind, polished yellow with a black spot on either side, otherwise vertex and front yellow pollinose; facial callositus exceedingly prominent polished yellow, except for a narrow yellow pollinose strip below the antennae; genae yellow except for a minute black spot below, polished only below the black spot, otherwise yellow pollinose; antennae very long, first segment unusually dilated (Fig. 14), yellowish; second segment somewhat dilated over the basal two-thirds, shorter than the third, yellowish; third black, first annuli somewhat lighter; thorax black in ground color; notum yellowish gray pollinose, thicker along two indistinct narrow lateral stripes; pleura

uniformly yellowish-gray pollinose; legs, including fore coxae, yellow except the joints, the apical third of the first tibiae, and the greater part of all tarsi which are black; wings (Fig. 8) peculiar in having the first submarginal discal and fourth posterior cells with prominent hyaline spots; abdomen dark in ground color, lighter on the caudal margin of segments; notum grayish-yellow pollinose and with two rows of subpolished dark spots.

One specimen has the abdomen yellow in ground color, which makes the spots of the dorsum more conspicuous. The hyaline spots in the dark cross-band are distinctive.

Holotype—Leeds, Utah, July 10, 1934 (Knowlton and Smith). In collection of the U. S. National Museum. *Paratypes*—One female, St. George, (Tanner); 20 specimens, Leeds, June 16, 1935 (Knowlton and C. J. Sorenson); Zion National Park, August 13, 1929; Pinturia, August 11, 1929; St. George, June 5–7, 1919, in Utah. Paratypes in the collections of the Entomology Departments of: Ohio State University, University of Kansas, Brigham Young University, Utah Agricultural Experiment Station, and of Dr. C. B. Philip.

Dr. C. B. Philip compared the material of *Chrysops dilatus* n. sp. with material of *C. pachycera* Will. in the University of Kansas collection. Dr. Philip reported that the Utah material would, in his opinion, constitute at least a good variety, although some workers might not consider that it should rank as a distinct species. The wing pattern is usually constant throughout the large series of Utah specimens examined.

Chrysops discalis Williston

Williston, Trans. Conn. Acad. Sci., 4: 245. 1880
Hine, Ohio Nat., 5: 221. 1904

Characteristics—General color gray; abdomen grayish with four rows of black spots; wings with discal cell hyaline.

Habitat—Many localities throughout northern and central Utah. This species is one of the most common and is particularly fond of open salt marshes.

Chrysops excitans Walker

Walker, Dept. Ins. Sound: 72. London. 1850
Osten Sacken, Prodome, 2: 373. 1875
Hine, Ohio Nat., 5: 222. 1904
Philip, Minn. Agr. Exp. Sta. Tech. Bul. 80: 84. 1931

Characteristics—Wings beyond cross-band hyaline; first two tergites yellow with a median black spot on each, that of the second deeply posteriorly emarginate; remainder of abdomen black.

Philip, 1931, declares *C. sordidus* Washb. (1905) a synonym.

Habitat—Uintah Mountains.

Chrysops fulvaster O. S.

O. S. Bull. U. S. Geol. Surv. of the Terr., 3: 221. 1887
Hine, Ohio Nat., 5: 223. 1904

Characteristics—The first antennal segment dilated; wings with the hyaline triangle separated from the posterior border of the wing; a brownish species.

Philip (1931) gives *Heterochrysops fulvaster* Krober (1928) as a synonym.

Habitat—This is the most common species of the genus in Utah and has been taken in numerous localities throughout the state. The females are vicious biters and readily attack man. It is a constant pest of domestic animals, especially those corralled near saltmarsh areas.

Chrysops lupus Whitney

Whitney, Canadian Entomologist, 36: 205. 1904
Hine, Ohio Nat., 5: 224. 1904
Philip, Minn. Agr. Exp. Sta. Tech. Bul. 80: 88. 1931

Characteristics—Wings with prominent apical spot, hyaline triangle extending across second long vein; abdomen predominately yellow; first and second tergite yellow, each with a median black spot, that of the second emarginate behind; third and fourth tergites each with four black spots, the lateral ones less prominent.

Habitat—Provo.

Some workers consider this species a synonym of *C. furcatus* Walk., but *C. lupus* has the lower half of the genae black while those of *C. furcatus* are entirely yellow. The distribution of the two seem to suggest that they are distinct species.

Chrysops mitis O. S.

O. S. Mem. Bost. Soc. Nat. Hist., 2: 374 (Prodome). 1875
Hine, Ohio Nat., 5: 224. 1904
Philip, Minn. Agr. Exp. Sta. Tech. Bul. 80: 89. 1931

Characteristics—This species can be separated from *C. carbonarius* by its somewhat larger size, the infuscation of the base of the fifth posterior cell, the infuscation along the sixth long vein, and the subhyaline appearance of the axillary lobe.

Habitat—Snowville.

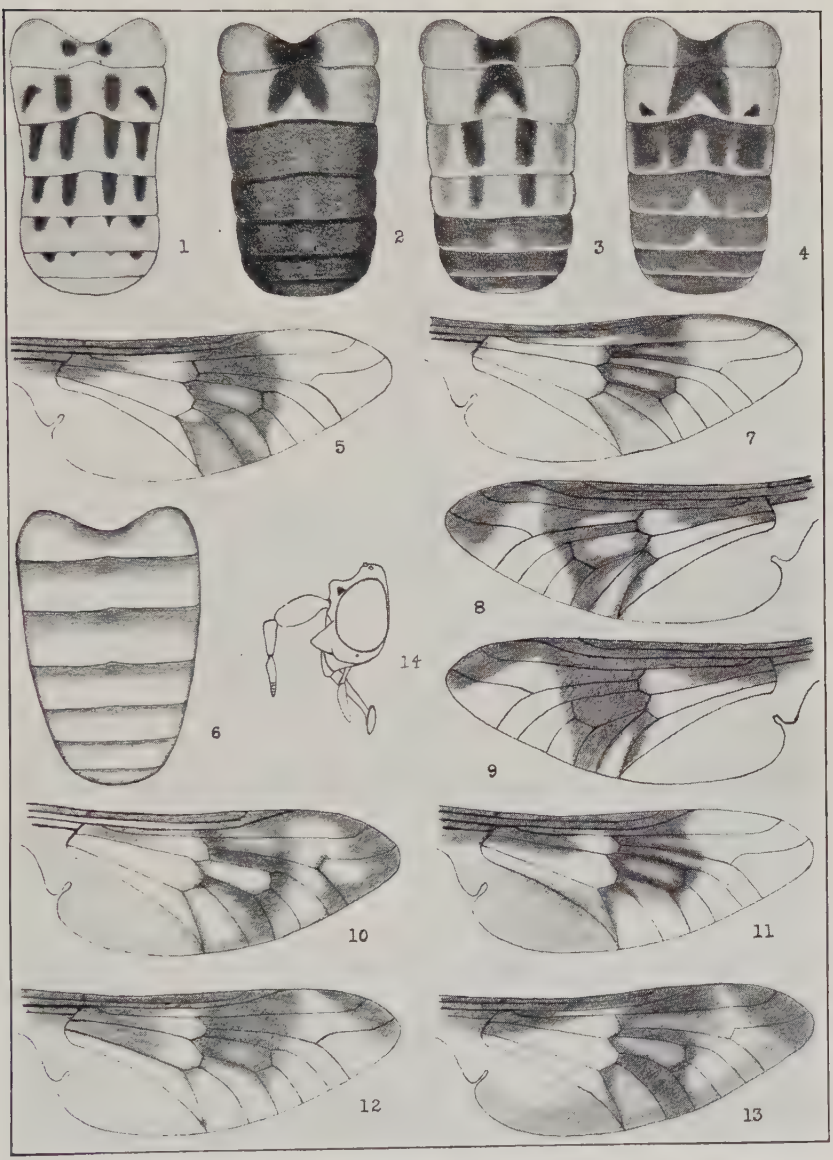
Chrysops noctifer O. S.

O. S. Bull. U. S. Geol. Surv. of the Terr., 3: 220. 1877
C. pertinax Will., Tran. Kan. Acad. Sci., 10: 132. 1886
C. nigriventris Big., Mem. Soc. Zool. Fr. 5: 604. 1892

Characteristics—Color black; tergites with white pile quite distinctly arranged on the lateral margins, a rather large lateral thinly pollinose spot on the first and second tergite, a distinct median row of spots which seem to fade out on the apical tergites; wings with the apical spot separated from the cross-band.

Habitat—Dry Canyon (Logan), Mirror Lake (Uintah Mts.), Aspen Grove (Timpanogos). This species seems to be more or less restricted to the mountainous areas of the state.

The synonomy is by Hine (1904).



Illustrations of Utah Pangoniinae

1. *S. quadrivittatus* (Say).
2. *C. excitans* Walker
3. *C. lupus* Whitney.
4. *C. aestuans* v. d. Wulp.
5. *C. carbonarius* Walker.
6. *O. californica* (Big.)
7. *C. aestuans* v. d. Wulp.
8. *C. dilatus* n. sp.
9. *C. coquillettii* Hine.
10. *C. discalis* Williston.
11. *C. mitis* O. S.
12. *C. noctifer* O. S.
13. *C. fulvaster* O. S.
14. *C. dilatus* n. sp.

SEVERAL NEW SILURIAN CEPHALOPODS AND CRINOIDS, CHIEFLY FROM OHIO AND HUDSON BAY

THE LATE AUG. F. FOERSTE

A. CEPHALOPODS

In 1927 a paper on the Ordovician and Silurian Cephalopods of the Hudson Bay Area was published by Aug. F. Foerste and T. E. Savage, in volume 22 of the Denison University Bulletin, Journal of the Scientific Laboratories. Since that time several specimens, collected by Professors Savage and Van Tuyl, have turned up and are described here.

Among these are two specimens from the Port Nelson limestone, described here under *Osbornoceras savagei*. These are of interest chiefly on account of their apparent similarity exteriorly to the genotype of *Osbornoceras*, namely, *Osbornoceras swinnertoni*, recently found in the Brassfield limestone in southwestern Ohio.

The Port Nelson limestone includes all of those Silurian strata in the Hudson Bay area which are below the top of the layers containing *Virginia decussata*. A few feet above this *Virgiana decussata* horizon there is a zone containing *Camarotoechia* (?) *winiskensis* Whiteaves, *Pterinea occidentalis* Whiteaves, *Isochilina latimarginata* Jones, and *Leperditia hisingeri fabulina* Jones. This horizon is included in the Severn River limestone. Both horizons occur at the Grand Rapids of the Saskatchewan river, near the northwestern margin of Lake Winnipeg. The fossils characteristic of the Severn River limestone occur also in the Wabi formation of the Lake Timiskaming area. In the northern peninsula of Michigan the fossils characteristic of the Severn River limestone overlie those containing *Virgiana mayvillensis* Savage, the latter being characteristic of the uppermost layers of the Mayville limestone in eastern Wisconsin.

The Port Nelson and Severn River formations are regarded as northern or Arctic invasions, while the Brassfield is regarded as a southern invasion. Both, however, are regarded as belonging to the Alexandrian division of the Silurian of Savage. Under these circumstances, the apparent occurrence of a species

in the Port Nelson formation of the Hudson Bay area congeneric with *Osbornoceras swinnertoni* of the Brassfield of southwestern Ohio is of considerable interest.

In the northern peninsula of Michigan the equivalent of the Severn River formation is known as the Burnt Bluff formation. The only cephalopod known hitherto from the Severn River formation of the Hudson Bay area was *Phragmoceras severnense* Foerste. Here *Laphamoceras vantuyli* is added. Unfortunately the structure of the interior of the latter is unknown.

Nine species are known from the overlying Ekwan River formation of the Hudson Bay area, and none is added here. Savage correlated this formation with the Manistique of northern Michigan, though its cephalopods suggest the upper part of the Burnt Bluff formation.

From the Attawapiskat formation 22 species of cephalopods were known, and two new species are added here. This formation appears to correspond approximately to the Racine in the presence of such genera as *Pentameroceras*, *Octameroceras*, and *Phragmoceras*, but not a single species of cephalopod can be identified definitely from both. Moreover, the Ekwan and Attawapiskat formations are regarded as northern invasions, while the typical Racine is not known north of the Milwaukee area of Wisconsin. The Racine, on the contrary, is represented by numerous identical species in the Cedarville formation of southwestern Ohio, and there are closely affiliated faunas in northwestern Ohio, southern Ontario, and northwestern New York. The known distribution of the Racine fauna is distinctly south of the Canadian shield, nothing similar to this fauna being known at present anywhere in subarctic or arctic areas.

1. **Orthoceras (?) attawapiskatense** new species

(Plate I, Fig. 7; Text Fig. 3)

The holotype is a small fragment of a conch including only a single camera and part of a second camera, but the septa of these two camerae are so peculiar in form as to provide a ready means of identification of the species. Each of the two camerae is about 6 mm. long. The cross section is circular; the diameter being 23 mm. The sutures of the septa appear straight and directly transverse. The septa are funnel-shaped, the sides diverging from each other at an angle of 56 degrees. The vertical length of these funnels is 17 mm. The smallest diameter preserved at their base is 5.5 mm. The center of this basal part is 8 mm. from the nearest wall of the conch, or 3.5 mm. from the center of the conch. In consequence, one side of the funnel is 20 mm. long, while the length of the opposite side is about 15 mm. Smoothing the

basal part of the funnel reveals a ring-like structure 4 mm. in diameter. This may indicate the size of the siphuncle, but the latter is not outlined definitely. The surface of the shell apparently was smooth. The rate of enlargement of the conch can not be determined with accuracy, but it appears to have been small.

Occurrence—Ekwan River, west of the northern end of James Bay, Canada, 38 miles above the mouth of this river, and two miles above the mouth of Strong River, half a mile below locality 903 of Savage and Van Tuyl. From the Attawapiskat limestone. Collected by T. E. Savage.

Remarks—The funnel-like form of the septa is anomalous among orthoceroids. At first glance it resembles the pseudosepta figured by Barrande in the case of various Silurian species found in Bohemia, but in the Hudson Bay specimen this form is characteristic of the septa themselves. The siphuncle is exposed only in cross section at the base of one of the funnels. Its segments are assumed to be nearly cylindrical, if enlarged at all within the camerae.

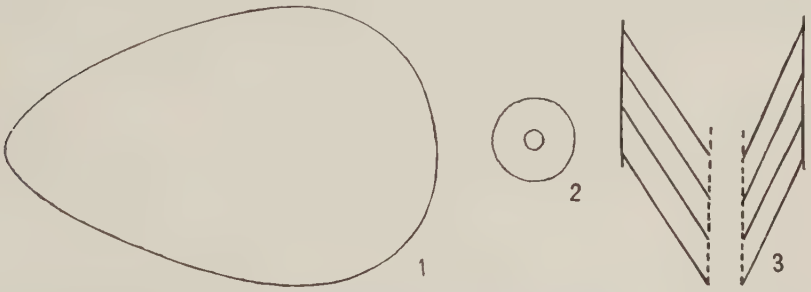


Fig. 1. *Osbornoceras swinnertoni;* cross-section of conch.
Fig. 2. *Spyroceras savagei;* cross-section showing siphuncle.
Fig. 3. *Orthoceras attawapiskatense;* vertical section showing septa and siphuncle.

2. **Spyroceras (?) savagei** new species

(Plate I, Figs. 3, 4; Text Fig. 2)

The holotype is 34 mm. long, 13 mm. of this length belonging to the living chamber. Its lateral diameter enlarges from 11.5 mm. near its base to 13.5 mm. at a point 25 mm. farther up. At the upper point mentioned its dorsoventral diameter is 2.5 mm., the conch being slightly depressed in that direction. At the top of the phragmacone, where its lateral diameter is 13 mm., there are 5 camerae in a length of 14 mm. The sutures of the septa are directly transverse. At the base of the specimen, the concavity of the septum is 1.6 mm. The diameter of the siphuncle here is 2.5 mm. Its segments are cylindrical in form, and there is no contraction at the septal necks. The location of the siphuncle is central. The surface of the shell is striated conspicuously both vertically and transversely. The vertical striae or ribs are more prominent, rising higher than the transverse ones. The more prominent of these number about 40 or 45 within the circumference of the conch.

On some parts of the surface there are less prominent vertical striae, alternating with the more prominent ones. Not enough of the surface of the shell is preserved to determine to what extent this alternation takes place. At one point, where 4 vertical striae occur in a width of 2.25 mm., there are 6 transverse ones in a length of 2.5 mm. The latter are less elevated, and hence less conspicuous. There are no distinct annulations, as in typical *Spyroceras*. Such annulations as exist are so faint as to be almost obsolete. They can be counted only along the living chamber, where the crests of 4 annulations occur in a length of 12.5 mm., the diameter of the conch here being about 13.5 mm.

Occurrence—Severn River, southwest of Hudson Bay, in the northern part of the Province of Ontario, Canada; near Limestone Island. From the Attawapiskat limestone. Collected by T. E. Savage.

Remarks—Among species already described, the one most nearly resembling this Hudson Bay specimen is the one described by Barrande[1] under the name *Orthoceras patronus* from the Devonian of Konieprus, Bohemia. In this Bohemian species the annulation is only slightly more distinct. The vertical ribbing or striation is closely similar, but the specimen figured first has more numerous transverse raised lines.

3. **Laphamoceras (?) vantuyli** new species

(Plate I, Figs. 5, 6)

Conch 48 mm. long, measured along its convex ventral outline. The radius of curvature of its convex ventral outline is about 35 mm. The specimen is crushed laterally. In its present condition its dorsoventral diameter increases from 7.5 mm. at its base to 15 mm. at a point 38 mm. farther up. At this upper point its present lateral diameter is 11 mm., but originally the lateral compression of the conch probably was moderate. Sutures of septa can be detected only between 8 and 19 mm. above the base of the specimen. At a dorsoventral diameter of 11 mm. there are about 7 camerae in a length of 10.5 mm. ventrally. The sutures of these septa are relatively straight and rise but slightly in a ventrad direction. No trace of the siphuncle is exposed, though, from the narrowness and depth of the hyponomic sinus this siphuncle is assumed to have been located close to the ventral outline of the conch. The length of the living chamber is unknown. The surface of the shell is both banded and striated transverse, the two types of ornamentation being parallel to each other. These markings are well preserved along the upper half of the specimen. Laterally they are almost straight, apparently rising in a ventrad direction. On approaching the ventral outline, however, they curve rapidly and increasingly downward, showing former locations of the hyponomic sinus. Along the upper part of the conch this sinus was V-shaped, about 6.5 mm. wide and 2 mm. deep, its basal outline rather narrowly rounded. There is a tendency toward angulation along the median part of the ventral side of the conch. Here the transverse bands tend to remain distinct, while the transverse striae become less sharply defined, or become obsolete locally.

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[1]Joachim Barraude. Systeme silurien du centre de la Boheme, Vol. 2, Pl. 275, Figs. 20–28 (1868).

Occurrence—From a loose boulder of Severn River limestone, presumably from Severn River, southwest of Hudson Bay. Collected by T. E. Savage.

Remarks—The genus *Laphamoceras* was founded on an Ordovician species, *Cyrtoceras tenuistriatum* Hall, from the Platteville member of the Black River. In it there are numerous closely crowded transverse striae which curve downward ventrally into a distinct V-shaped sinus. The resemblance of the Hudson Bay specimen to the Black River genotype probably is confined to its external features.

OSBORNOCERAS new genus

Genotype: *Osbornoceras swinnertoni* Foerste.

Cyrtoceracones cuneate-ovate in cross section, narrowly rounded ventrally, much more broadly rounded dorsally. Sutures of septa rising distinctly higher ventrally than dorsally. Siphuncle located near the ventral outline of the conch but not in contact with the latter; segments elongated vertically, nearly twice as long as wide, enlarging only moderately within the camerae, their dorsal outlines nearly straight, their ventral outlines distinctly though moderately convex. Living chamber contracting both dorsoventrally and laterally toward the aperture; lateral margins of the aperture curving upward, sloping strongly downward ventrally, indicating a relatively deep and narrow hyponomic sinus. Dorsal side of aperture uncertain.

Known at present only from the Alexandrian division of the Silurian.

4. **Osbornoceras swinnertoni** n. sp.

(Plate I, Figs. 1, 2; Text Fig. 1)

Specimen 126 millimeters long in a direct line, but about 162 mm. long when measured along its convex ventral outline. The radius of curvature of this ventral outline is 75 millimeters along the phragmacone and approximately the same along the living chamber. The corresponding radius of curvature of the concave dorsal outline is 50 mm. The maximum length of the living chamber along the median part of its lateral side is 67 mm. The dorsoventral diameter of the conch enlarges from 38 mm. at the base of the specimen to 55 mm. at the base of the living chamber, which is 105 mm. farther up when measured along its ventral outline. Apparently there is a slight contraction dorsoventrally along the upper part of the living chamber, but the ventral outline of this part of the chamber is not preserved. The lateral diameter of the conch enlarges from about 22.5 mm. at the base of the specimen to 38 mm. at the base of the living chamber, contracting to 32 mm. at its top. The cross section of the conch is cuneate. At the base of the living chamber, where its dorsoventral diameter is 55 millimeters, the maximum lateral diameter of the conch is located 20 mm. from its concave dorsal outline. The dorsal side of the cross section of the conch at the base of the living chamber has a radius of transverse curvature of 20 mm. The corresponding radius of transverse curvature of its narrow ventral edge is 5 mm. The ventrolateral sides are strongly flattened and converge

strongly toward the ventral outline of the conch. The number of camerae in a length equal to the dorsoventral diameter of the conch varies from 6 at a diameter of 49 mm. to a little over 7 at a diameter of 55 mm. The sutures of the septa curve downward laterally, their maximum downward curvature being located at the maximum lateral diameter of the conch. In a dorsad direction these sutures rise only slightly. In a ventrad direction they rise at an increasing rate on approaching the base of the living chamber, attaining an elevation of 10 or 12 mm. above the lowest part of their course at the top of the phragmacone. The passage of the siphuncle through the septum at a point 50 mm. beneath the ventral side of the base of the living chamber is 2 mm. in diameter, enlarging to 4 mm. within the camerae. The septal necks are about 1 mm. long, and contract strongly along their dorsal sides, but much less ventrally. The dorsal outline of the connecting rings is almost straight, but their ventral outline is distinctly convex. Faint traces of transverse undulations of growth cross the surface of the cast of the interior of the living chamber. These undulations curve upward along the lateral sides of the chamber, reaching their greatest elevation near the maximum lateral diameter of the conch. Thence they curve downward about 20 mm. in a ventrad direction, but only slightly in a dorsad direction. From this it is assumed that the hyponomic sinus was long, deep, and narrow. The shell appears to have attained a thickness of 1.5 mm. along the dorsal side of the living chamber, thinning to less than half a millimeter ventrally. The surface of the shell apparently was smooth.

Occurrence: From the Brassfield limestone, in the quarry of the Southwestern Portland Cement Company, about one-third of a mile southeast of Osborn, in the northwestern corner of Greene County, Ohio. Collected by Theodore Sawyer and donated by Prof. A. C. Swinnerton. U. S. National Museum No. 91091.

5. **Osbornoceras (?) savagei** n. sp.

(Plate II, Fig. 1)

Specimen 120 mm. long in a direct line, but about 131 mm. long when measured along its ventral outline. Along this ventral outline the phragmacone occupies a length of 57 mm., and the living chamber a length of 74 mm. as far as the lower margin of the hyponomic sinus. The radius of curvature of the convex ventral outline is 100 mm. The dorsoventral diameter of the conch enlarges from 44 mm. at its base to 50 mm. at the base of the ventral side of the living chamber, to 51 mm. at a point 45 mm. farther up, and then diminishes to 45 mm. at the lower margin of the hyponomic sinus after an additional interval of 29 mm., the dorsoventral contraction here being due chiefly to a slight incurvature of the ventral outline of the chamber. The original cross section of the specimen is assumed to have been similar to that of the genotype, *Osbornoceras swinnertoni*, with the general form cuneate, the dorsal side more broadly rounded, and the ventrolateral sides converging strongly toward the much more narrowly rounded ventral part of the section. At present, however, this cross section is more

compressed laterally, especially along its dorsal side, so that the lateral diameter of the conch is estimated at 18 mm. at its base, and increases thence to about 24 mm. at a point 25 mm. above the base of the living chamber, diminishing to about 18 mm. at the aperture. Along the ventral side of the lower part of the living chamber the more narrowly curved part of the ventral side of this cross section has a radius of curvature of 3 or 4 mm., while dorsally the corresponding radius is approximately 7.5 mm. In consequence, the cross section of this specimen is more lenticular than cuneate, but with the dorsal side more broadly rounded. Nine camerae are preserved. Of these, the upper three occupy a total length of 18 mm. ventrally, the intermediate three of 22 mm., and the lower three of 17 mm. The sutures of the septa curve only slightly downward along the dorsal half of their course, but rise distinctly along their ventral half, the amount of this rise equalling about 9 mm. along the upper part of the phragmacone. The siphuncle is not preserved but is assumed to be located as in the genotype. The lateral margin of the aperture appears to rise upward, attaining its greatest elevation dorsad of the center of the conch. Its downward curvature in a ventrad direction equals about 8 mm., indicating the former presence of a long and narrow V-shaped hyponomic sinus. In a dorsad direction the downward curvature of this margin appears much less. The surface of the shell is not preserved distinctly, but appears to have been smooth.

Occurrence: From 4 miles above the Lower Rapids of the Nelson River, 18 miles below the mouth of Limestone River; from the Port Nelson limestone.

Remarks: Osbornoceras savagei differs from *Osbornoceras swinnertoni* in the smaller lengthwise curvature of its conch, the smaller rate of enlargement of its phragmacone dorsoventrally, the greater length of its living chamber, and the less rapid rise of the sutures of its septa along the ventral half of their course. The more narrow rounding of the dorsal side of its cross section is ascribed to compression of the conch after the death of the animal.

6. **Phragmoceroid** (?)

(Plate II, Fig. 2)

A second specimen, from the same locality and horizon as *Osbornoceras savagei*, appears to be more erect, its right outline as figured being slightly convex. The living chamber is shorter and the left part of its upper margin appears contracted, as though outlining the dorsal lobe of the aperture of some phragmoceroid. However, there is no evidence that the right side of its aperture projected in the form of a spout similar to the hyponomic sinus of phragmoceroids. Therefore the systematic position remains in doubt. It is figured here in contrast with typical *Osbornoceras savagei*, both being from the Port Nelson limestone, 4 miles below the Lower Rapids of the Nelson River.

OXYGONIOCERAS Foerste

Genotype: *Trochoceras oxynotum* Barrande, Systeme Silurien du Centre de la Boheme, Vol. 2, p. 91, Pl. 14, Figs. 1–11 (1867); *Oxygonioceras oxynotum* Foerste, Jour. Sci. Labs. Denison Univ., Vol. 21, p. 62 (1926); Vol. 21, p. 375, Pl. 42, Figs. 1 A-E (1926).

Cross section of conch ovate cuneate, with the ventral side narrowly but not sharply rounded, the dorsal side much more broadly rounded. Conch curved lengthwise, the siphuncle located on its convex outline. In the genotype the segments of the siphuncle enlarge strongly within the camerae, their lateral diameter equallin about 1.7 times their height. This genotype is from the Middle Silurian of Bohemia, at present a part of Czechoslovakia.

7. Oxygonioceras (?) cuneatum (Whiteaves)

Cytoceras (?) *cuneatum* Whiteaves. Geol. Surv. Canada, Vol. 3, Pt. 4, p. 282 (1906); Ottawa Naturalist, Vol. 20, p. 133. Text Figs. A, B, (1906).
Oxygonioceras cuneatum Foerste. Jour. Sci. Labs., Denison Univ., Vol. 21, p. 63 (1925)

The holotype is from the Silurian at Stonewall, Manitoba. Regarding the location of its siphuncle Whiteaves stated: "Shape and position of siphuncle not very clearly defined in the only specimen collected, though at the smaller end thereof there are indications that it was eccentric and placed a little on the ventral side of the center, as represented in Fig. B." In this Figure, published in the *Ottawa Naturalist*, the dorsoventral diameter of the conch is drawn as 27.5 mm. long, the passage of the siphuncle through the septum being almost 2 mm. in diameter, and its center being 10.5 mm. from the cuneate ventral side of the conch.

Unfortunately this holotype has been lost, so that the subcentral location of the siphuncle can not be verified. Usually cyrtoceroids with a subangular ventral outline have the siphuncle located near the convex ventral outline of the conch, and a subcentral location of the siphuncle should not be accepted unless clearly indicated. Whiteaves's statement that the shape and position of the siphuncle are not very clearly indicated increase the uncertainty as to the subcentral location of the latter. In other words, there is a possibility that the siphuncle in this species was located near its subangular convex outline, as in *Oxygonioceras*. Should, however, the subcentral location of the siphuncle ever be verified then the Stonewall specimen would necessarily be excluded from *Oxygonioceras*.

8. Oxygonioceras (?) wabashense n. sp.

Oxygonioceras cf. *cuneatum* Foerste. Notes on cephalopod genera; chiefly coiled Silurian forms. Jour. Sci. Lab., Denison Univ., Vol. 21, p. 63, Pl. 21, Figs. 1A, B, C, (1925).

The specimen from the Niagaran at Wabash, Indiana, differs from the species originally described by Whiteaves as *Cyrtoceras cuneatum* in its less rapid rate of curvature lengthwise, and in the greater number of camerae in a length equal to the dorsoventral diameter of the conch. In its present condition, the dorsal side of the cross section of the conch

is much more angular along its median line, but this feature may be due in part to lateral compression of the conch after the death of the animal.

B. BRASSFIELD CRINOIDS

Unidentifiable fragments of crinoids are common in the upper part of the Brassfield formation in Ohio and Kentucky east of the Cincinnati anticline; however, remains at least generically identifiable are rare, and specimens suitable for the erection of species are still rarer. The little that was known in 1919 was included in a paper on the Echinodermata of the Brassfield (Silurian) Formation in Ohio published by the writer in volume 19 of the Denison University Bulletin, Journal of the Scientific Laboratories.

Most characteristic of these crinoidal remains are numerous detached flat columnals, often attaining diameters of 12 or 13 mm., but occasionally equalling 22 mm. and even 28 mm. in diameter. These columnals are specially common at the top of the Brassfield. Rarely these columnals are found still forming a continuous stem. The stem illustrated in the publication cited above was a little over 150 mm. long and formed a loose flat coil 41 mm. in diameter with its smaller end at the center. This stem enlarged in diameter from slightly over 1 mm. at its smaller end to about 8 mm. at its top. Short strands of larger columnals also occur, evidently fragments of much longer stems. Unfortunately, no calices which could belong to these stems have been found. The loose columnals occur from Dayton, Ohio, southward as far as the Cumberland River, in the southwestern part of Pulaski County, Kentucky.

A single stem, described as *Eomyelodactylus rotundatus* Foerste, was found on Caesar Creek, nearly five miles southeast of Xenia, Ohio. Parts of calices, described as *Dimerocrinus* (?) *vagans* Foerste, were found seven miles northwest of Xenia, at a locality reached by going from Byron one mile east and then one mile south, east of the road. Here also was found the specimen described as *Stereoaster squamosus*, but the latter at present is regarded as merely the badly weathered under side of the tegmen of some unknown crinoid.

Fragments of calices have turned up more frequently in the upper part of the large quarry at Centerville, Ohio, than elsewhere. Occasionally a good head is found. One of these was described in the publication mentioned above merely as

Clidochirus sp., since it was discovered before publication that Springer already had figured another specimen belonging to the same species under the name *Clidochirus americanus*. At present three specimens of this species are in the U. S. National Museum.

Among the other specimens figured from the Centerville quarry in the publication cited above the one doubtfully identified as a Platycrinid may be a *Patelliocrinus*, and that doubtfully referred to *Cyathocrinus* may be a *Pycnosaccus*. Until better preserved specimens are found their exact relationship must remain in doubt.

Recently two specimens were found in the upper part of the Brassfield formation at Centerville which evidently belong to the Calceocrinidae. Both are alike in having a median arm which branches on the fifth primibrach. However, in the smaller specimen this arm branches again on the third secundibrach, while in the larger specimen this branching can not take place earlier than the fourth secundibrach, and may take place later, as far as can be determined from the specimen at hand in which the sutures above the fourth secundibrach are poorly defined. In the smaller specimen the lateral arms present five erect branches of the type described in full by Springer for the genera *Calceocrinus* and *Halysiocrinus*. In the larger specimen, however, it is impossible to determine definitely whether the lateral arms branch as in *Eucheirocrinus* or as in *Calceocrinus*. Of the branches of the lateral arms only those nearest the median arm are preserved distinctly, and these in their present state of preservation could be referred to *Eucheirocrinus* almost as readily as to *Calceocrinus*. In the smaller specimen the brachs of the median arm are much more compressed laterally than in the larger one; moreover the upper parts of both the median and the lateral arms curve more strongly toward the posterior side of the crown. The sutures separating the basals are poorly indicated, but apparently there are only three basals. In both specimens the two segments of the radial supporting the median arm appear to be in narrow contact with each other. In the smaller specimen the columnals of the stem appear to become moderately longer in a distal direction, while those of the larger specimen are subequal.

Owing to the differences here noted the smaller specimen is described as *Calceocrinus centervillensis*, while the larger one is separated as *Calceocrinus* (?) *incertus*.

9. **Calceocrinus centervillensis** new species

(Plate II, Figs. 3, 4)

The holotype is 17.5 mm. long, 5.5 mm. of this length belonging to the calyx. Apparently only 3 basals are present, no suture being detected along the middle of the median triangular basal. The apex of this plate is very near the base of the stem, but apparently it is not in actual contact with the latter. The two segments of the radial supporting the median arm apparently are in very narrow contact with each other, but sutures here are very indistinct. The brachials of the median arm are strongly convex transversely and their outer surface is minutely granulate. This arm branches on its fifth primibrach. Only the right branch is preserved and this branches on its third secundibrach. The main axis of the lateral arms rises at a strong angle and gives rise to 5 erect branches. These erect branches divide heterotomously, one of the two branches usually being distinctly smaller than the other. These smaller branches are formed alternately first on one side of the larger branch then on its opposite side. Unfortunately, in the specimen at hand, only glimpses of the smaller branches are secured as a rule, and not infrequently the sutures between the brachs are not distinct. The stem is preserved for a length of 5.5 mm. The columnals apparently enlarge in a distad direction.

Occurrence: Quarry northeast of Centerville, Ohio. From the clay layers at the top of the Brassfield formation. U. S. National Museum, No. 91093.

10. **Calceocrinus (?) incertus** new species

(Plate II, Figs. 5, 6, 7, 8)

The holotype is 28 mm. long, 7.5 mm. of this length belonging to the calyx. This calyx narrows from a width of nearly 7 mm. near its base to 6 mm. a short distance beneath its top. The gap between the basals and radials is lenticular in outline and is 6 mm. wide and 1.5 mm. long. Apparently there is only a single median triangular basal. The two segments of the radial supporting the median arm apparently meet at a point. This median arm branches on its fifth primibrach. Both branches present a straight transverse suture at the top of the third secundibrach; each may have branched on the fourth secundibrach, but that is uncertain. The proximal erect branch of the right lateral arm branches several times, but it is impossible to determine whether this branching is similar to that of *Calceocrinus* or of *Eucheirocrinus*. Apparently the primary part of this right lateral arm arises as in *Calceocrinus centervillensis*, giving off vertical branches, but this can not be determined definitely. The brachials of both the median and lateral arms are less convex than in the preceding species. The surface of both calyx and arms is granulate, the granules being preserved locally. The stem is preserved for a length of 8 mm. Throughout this length its segments are short and disc-like, the crests of 5 columnals occurring in a length of 2 mm., the diameter of the stem being 1.6 mm.

Occurrence: Quarry at the northeast margin of Centerville, Ohio. From clay layers at the top of the Brassfield formation. U. S. National Museum, No. 91092.

EXPLANATION OF PLATES

Plate I

Figs. 1, 2. *Osbornoceras swinnertoni* Foerste. 1, lateral view with ventral outline on left; 2, dorsoventral section through siphuncle, oriented as in Fig. 1. Osborn, Ohio; from Brassfield limestone. See also Text Fig. 1. U. S. National Museum, No. 91091.

Figs. 3, 4. *Spyroceras* (?) *savagei* Foerste. 3, natural size; 4, same, enlarged three diameters, slightly turned toward right. Severn River, near Limestone Island, Hudson Bay area; from Attawapiskat limestone. See also Text Fig. 2. Savage collection.

Figs. 5, 6. *Laphamoceras* (?) *vantuyli* Foerste. 6, lateral view with ventral outline on left; 6, oblique dorsal view showing downward curvature of transverse striae along former locations of hyponomic sinus. Loose boulder, Severn River, Hudson Bay area; from Severn River limestone. Savage collection.

Fig. 7. *Orthoceras* (?) *attawapiskatense* Foerste. Lateral view, showing funnel-shaped septum at its base. Ekwan River, two miles above Strong River, Hudson Bay area; from Attawapiskat limestone. See also Text Fig. 3. Savage collection.

Plate II

Fig. 1. *Osbornoceras* (?) *savagei* Foerste. Lateral view with left outline regarded as ventral. Four miles above Lower Rapids of Nelson River; from Port Nelson limestone. Savage collection.

Fig. 2. *Phragmoceroid* (?). Lateral view, oriented as in preceding figure. Four miles above Lower Rapids of Nelson River; from Port Nelson limestone. Savage collection

Figs. 3, 4. *Calceocrinus centervillensis* Foerste. 3, showing calyx and median arm; 4, lateral view with median arm on left; also 5 vertical branches of right lateral arm. Quarry on northeast margin of Centerville, Ohio; from top of Brassfield formation. U. S. National Museum, No. 91093.

Figs. 5, 6, 7, 8. *Calceocrinus incertus* Foerste. 5, showing calyx, median arm, and adjacent parts of the two lateral arms; 6, left side, showing calyx with stem on left side, and with median arm on right outline, also adjacent part of left lateral arm; 7, posterior side of calyx showing the stem attached to its base and curved upward parallel to the calyx; 8, calyx viewed from beneath and showing the gap at the hinge between the basals and the radials, stem attached to the basals and curving strongly upward, parallel to the posterior side of the calyx. Quarry at northeastern margin of Centerville, Ohio; from the top of the Brassfield limestone. U. S. National Museum, No. 91092.

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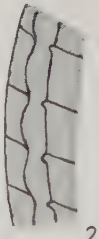

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NOTES ON THE CARABIDAE OF OHIO

I. Tetragonderus fasciatus Hald., Bembidium laevigatum Say, and Geopinus incrassatus (Dej.) in Ohio (Coleoptera—Carabidae)

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While perusing some of the earlier volumes of Entomological literature, one is impressed by the wealth of observations recorded as notes, particularly upon the abundance and distribution of various species of insects. It is regretable that such a faculty for observation and writing of such notes is lacking in the majority of the present day workers in entomology, although there appears to be an increase in the publication of such records in recent years.

It is with this thought in mind, that the information here presented may be of use to others in not only extending the knowledge of the fauna in areas similar to Ohio, but also to extend and enlarge the collections already extant in this state, rather than the assumption that these records present a complete picture of the distribution of these species in Ohio.

On June 24, 1933, while on a collecting trip in Hocking County, the first specimens of *Tetragonderus fasciatus* Hald. were observed in their natural habitat. This occurred quite accidentally while seated upon a bank of white sand along Salt Creek, about three miles west of South Bloomingville, resting from the exertions and the heat of the day. It was noticed that when the base of the clumps of grass and other plants growing in the sand were disturbed, a small whitish-appearing beetle, later identified as the above species, scurried to a new hiding place. The smallness of the insects and the instability of the loose sand, made capture rather difficult without injury to the specimen. A rather intensive search resulted in the capture of six specimens. Upon returning the next day to same locality, four more specimens were secured.

Prior to this date, only five specimens of *T. fasciatus* had been taken. The first of these was collected among stones close to the water edge, along the Portage River, two miles northwest of Pemberville, in Wood County, Ohio, on June 13,

[1]Joint authors.

1931. Two other specimens were taken on May 25, 1933, and the remaining two on June 5, 1933, in Lucas County (Adams Township, Section 23), along a gravel road, about two miles north of Maumee. These specimens in both instances were attracted to the headlamps of the automobile, while parked collecting other insects.

Since this observation was made in Hocking County, some 122 specimens have been taken. The largest collection was made in this same county, just south of Logan, along the west bank of the Hocking River, just south of the Chesapeake and Ohio railroad bridge (Falls Township, Section 14), on August 5, 1934, when 54 specimens were collected. In Gallia County, along the sandy banks of a small stream a few miles north of Vinton (Huntington Township, Section 13), 40 individuals of this species were secured on August 7, 1934. The only other locality where this species was noted in rather abundant numbers was in Holmes County along Paint Creek, a few miles south of Holmesville (Prairie Township, Section 9), where 14 specimens were collected on August 3, 1934. One specimen was taken in Fairfield County (Berne Township), near Sugar Grove, along Hocking River, on June 1, 1935.

While examining material in this family in other collections made in this state, only seven other specimens of this species were noted. One was in the Dury collection at Cincinnati, and was labeled Cincinnati, Ohio, 6–27–5, no collector indicated. Mr. Ralph Dury, Director of the Cincinnati Museum of Natural History, states that this species is quite abundant in the vicinity of this city in habitats similar to that described above. Four are in the collection of the Ohio Agricultural Experiment Station, at Wooster, Ohio, one from Ashtabula, Ohio, and three from Cedar Point, Ohio, and two are in the collection of the Ohio University at Athens, Ohio, collected by Dr. Stehr on white sand along Hocking River at Athens.

In the records of the Ohio Biological Survey there is a record of this species being taken by Mr. Sim in Erie County, at Cedar Point, on July 15, 1912. There is no statement as to the number collected, nor were any specimens seen.

The following tabulation summarizes the present knowledge of the distribution of this species in Ohio, so far as it is known:

Athens County, Ohio.
Athens, Ohio, May 21, 1935..... 2 sp. W. C. Stehr.
Ashtabula County, Ohio.
Ashtabula, Ohio, 6–9–1899..... 1 sp. (?).

Erie County, Ohio.		
Cedar Point, Ohio, July 15, 1912	?	Sim (O. B. S. record).
Cedar Point, Ohio, 7–10–1899	3 sp.	(?)
Fairfield County, Ohio.		
Berne Twp., Sugar Grove, June 1, 1935	1 sp.	R. T. Everly.
Gallia County, Ohio.		
Huntington Twp., Sec. 13, Aug. 7, 1934	40 sp.	L. W. & R. T. Everly.
Hamilton County, Ohio.		
Cincinnati, Ohio, 6–27–5	1 sp.	(?).
Hocking County, Ohio.		
Scenic Inn, near Ash Cave, Aug. 5, 1934	4 sp.	L. W. & R. T. Everly.
Conckle's Hollow, Aug. 6, 1934	1 sp.	L. W. & R. T. Everly.
Falls Twp., Sec. 14, Aug. 5, 1934	54 sp.	L. W. & R. T. Everly.
Salt Creek Twp., Sec. 24, June 24, 1933	6 sp.	L. W. & R. T. Everly.
Salt Creek Twp., Sec. 24, June 25, 1933	4 sp.	L. W. & R. T. Everly.
Holmes County, Ohio.		
Prairie Twp., Sec. 9, Aug. 2, 1933	3 sp.	R. T. Everly.
Prairie Twp., Sec. 9, Aug. 3, 1933	14 sp.	R. T. Everly.
Lucas County, Ohio.		
Adams Twp., Sec. 23, May 25, 1933	2 sp.	L. W. and R. T. Everly.
Adams Twp., Sec. 23, June 5, 1933	2 sp.	L. W. and R. T. Everly.
Adams Twp., Sec. 23, Sept. 8, 1933	2 sp.	R. T. Everly.
Washington Twp., Sec. 8, in sandy tomato field, Aug. 4, 1934	2 sp.	R. T. Everly.
Wood County, Ohio.		
Freedom Twp., Sec. 1, June 13, 1931	1 sp.	R. T. Everly.

Another species taken in close association with *T. fasciatus* was *Bembidium laevigatum* Say. This latter species was not nearly so abundant, and has been taken in habitats other than that where *T. fasciatus* is commonly found. In Hocking County, south of Logan (Falls Township, Section 14), where 54 specimens of *T. fasciatus* were collected, 7 specimens of *B. laevigatum* were also taken on August 5, 1934. In a similar habitat in Holmes County (Prairie Township, Section 9), on July 31, August 2, and August 3, 1933, six individuals of the latter species were secured. In the Dury collection there were four specimens from Cincinnati, two without dates, the others dated 7–12–5 and 7–11–13. None of the specimens bore collector labels. Mr. Ralph Dury corroborates the observation that this species occurs in a similar habitat and at the same time as *T. fasciatus*.

The first specimens of *B. laevigatum* observed were collected just north of Lake Alma in Jackson County, under stones on the western slope of a bare hill, on April 3, 1932, and on June 23, 1933, two specimens were collected in Hocking County (Salt Creek Township, Section 24), along Salt Creek, three miles west of South Bloomingville, where the largest series of this species was secured on August 5, 1934. The stream had been high recently and with the abatement of the water, had

deposited a heavy layer of silt upon the bank. This deposit dried rapidly, forming large cracks. By pressing these cracks together with the feet, a number of insects were forced out by the pressure, and among these were nine specimens of *B. laevigatum.* One individual of this species was taken on the bank of the Ohio River near the Gallipolis Airport on August 7, 1934, four specimens were secured along the banks of the Auglaize River, just north of Cascade, Ohio, in Putnam County (Perry Township, Section 21), on May 21, 1934, and in Coshocton County one was secured along the Walhonding River near Six Mile Dam near Warsaw (Bethlehem Township, central portion), and three from along the Koskosing River near its confluence with the Mohican River (New Castle Township, northwest portion), on May 25, 1935.

In addition to the specimens in the Dury collection, the following specimens have been seen. Two specimens are in the collection of the Ohio State Archaeological and Historical Society at Columbus, Ohio, one from along the Olentangy River north of the University Campus, and the other from Fairfield County (Berne Township), and one specimen labeled Columbus, Ohio, is in the Hines collection at the same place. Two are in the Ohio University collection at Athens, one from Athens, Ohio, and the other from Meigs County. In a thesis presented for the degree of Master of Science at Ohio State University in 1916 by T. L. Guyton, is recorded one specimen of this insect, collected upon milkweed in Guernsey County, Madison Township.[2]

Four of these specimens herein recorded as *B. laevigatum* show marked differences and may be characteristic enough to warrant at least a variety name. However, rather than retard the publication of this data by the necessary study required to verify these differences, they are here included as this species.

The following list summarizes the distribution of *B. laevigatum* in Ohio:

Athens County, Ohio.		
Athens, Ohio, 4-28-34	1 sp.	H. Bauman.
Coshocton County, Ohio.		
New Castle Twp., N. W., May 25, 1933	3 sp.	R. T. Everly.
Bethlehem Twp., C, May 25, 1933	1 sp.	R. T. Everly.

[2]Although this specimen was not seen, its identification can be reasonably assumed, as the species is very characteristic in both shape and coloration, and not easily confused with other species of Carabidae.

FAIRFIELD COUNTY, OHIO.		
Berne Twp., X–15–33	1 sp.	H. Goslin and E. S. Thomas.
FRANKLIN COUNTY, OHIO.		
Columbus, Ohio, (?)	1 sp.	(?).
Columbus, Ohio, May 27, 1933	1 sp.	William Ross.
GALLIA COUNTY, OHIO.		
Gallipolis Airport, Aug. 7, 1934	1 sp.	L. W. and R. T. Everly.
GUERNSEY COUNTY, OHIO.		
Madison Twp., (?)	1 sp.	T. L. Guyton.
HAMILTON COUNTY, OHIO.		
Cincinnati, Ohio, 7 12–'5	1 sp.	(?).
Cincinnati, Ohio, 7-11-13	1 sp.	(?).
Cincinnati, Ohio, (?)	2 sp.	(?).
HOCKING COUNTY, OHIO.		
Salt Creek Twp., Sec. 24, June 23, 1933	2 sp.	L. W. and R. T. Everly.
Salt Creek Twp., Sec. 24, Aug. 5, 1934	9 sp.	L. W. and R. T. Everly.
Falls Twp., Sec. 14, Aug. 5, 1934	7 sp.	L. W. and R. T. Everly.
HOLMES COUNTY, OHIO.		
Prairie Twp., Sec. 9, July 31, 1933	1 sp.	R. T. Everly.
Prairie Twp., Sec. 9, Aug. 2, 1933	1 sp.	R. T. Everly.
Prairie Twp., Sec. 9, Aug. 3, 1933	4 sp.	R. T. Everly.
JACKSON COUNTY, OHIO.		
Lake Alma, April 3, 1932	2 sp.	L. W. and R. T. Everly.
MEIGS COUNTY, OHIO.		
Syracuse, Ohio, 8-16 33	1 sp.	W. C. Stehr.
PUTNAM COUNTY, OHIO.		
Perry Twp., Sec. 21, May 21, 1934	4 sp.	L. W. and R. T. Everly.

On the evening of May 25, 1933, returning from a collecting trip along the Maumee River just after dark, while driving along a by-road surfaced with very fine gravel, in Lucas County (Adams Township, Section 23), several large beetles were observed in the light from the headlamps of the automobile, crawling upon the road. Upon stopping these were found to be *Calosoma calidum* Fab. and *Scarites substriatus* Hald. While these specimens were being secured, another large, robust, light brown colored beetle, later identified as *Geopinus incrassatus* (Dej.), began coming to the light in large numbers. Unfortunately the collecting jars being used were shell vials, one inch by six inches, and as these insects are rather large, the remaining vials were soon filled, some 37 specimens being taken. Upon the returning the next evening, no specimens were secured, but the night of June 3, 1933, 10 more were taken, and on June 8, 1933, 8 more were secured at the same location. During the same year 7 more individuals were collected at lights in East Toledo, Ohio, from June 5, 1933, to June 30, 1933. Of a total of 63 specimens collected in 1933 and 1934, all but one from Lake County, were taken at lights.

Dr. W. C. Stehr has taken one at Athens, Ohio, on October 29, 1931, at lights.

In addition to the last mentioned specimen, there are in the Dury collection six specimens bearing a Cincinnati, Ohio, label. Two specimens are in the collection of the Ohio State Archaeological Museum at Columbus, Ohio, one is from Cincinnati, collected by Miss Annette F. Braun on September 29, 1908, and the other is from Geauga County, taken by Mr. M. E. Crago, and three specimens in the University collection at the same location, one collected from Columbus, Ohio, on May 25, 1906, by Dr. James S. Hine, and two specimens from Geneva, Ohio, Ashtabula County, taken in June, 1909, by Mr. R. J. Sim. In the collection of the Department of Zoology and Entomology of the Ohio State University, there is one other specimen from Ashtabula County, taken by Mr. Sim, at Ashtabula, Ohio, on August 27, 1911. The records of the Ohio Biological Survey show this species as having been taken by Mr. Sim in Erie County, at Cedar Point, on July 1, 1912; there was no indication of the number of specimens.

The following summarizes the known distribution of *G. incrassatus* in Ohio:

ATHENS COUNTY, OHIO.		
Athens, Ohio, 10–29–1931	1 sp.	W. C. Stehr.
ASHTABULA COUNTY, OHIO.		
Geneva, Ohio, 6–09	2 sp.	Robt. J. Sim.
Ashtabula, Ohio, Aug. 27, 1911	1 sp.	R. J. Sim.
ERIE COUNTY, OHIO.		
Cedar Point, Ohio, July 1, 1912	(?)	Sim (O. B. S. record).
FRANKLIN COUNTY, OHIO.		
Columbus, Ohio, V–25–06	1 sp.	Jas. S. Hine.
GEAUGA COUNTY, OHIO.		
(?), 1934 (?)	1 sp.	M. E. Crago.
HAMILTON COUNTY, OHIO.		
Cincinnati, Ohio, Sept. 29, 1908	1 sp.	Annette F. Braun.
Cincinnati, Ohio, (?)	6 sp.	(?).
LAKE COUNTY, OHIO.		
Perry Twp., N. E. on beach, June 17, 1934	1 sp.	L. W. Everly.
LUCAS COUNTY, OHIO.		
Adams Twp., Sec. 23, May 25, 1933	37 sp.	L. W. and R. T. Everly.
Adams Twp., Sec. 23, June 3. 1933	10 sp.	L. W. and R. T. Everly.
Adams Twp., Sec. 23, June 8, 1933	8 sp.	L. W. and R. T. Everly.
East Toledo, Ohio, June 5, 1933	2 sp.	L. W. and R. T. Everly.
East Toledo, Ohio, June 6, 1933	3 sp.	L. W. and R. T. Everly.
East Toledo, Ohio, June 7, 1933	1 sp.	L. W. and R. T. Everly.
East Toledo, Ohio, June 30, 1933	1 sp.	L. W. and R. T. Everly.
PUTNAM COUNTY, OHIO.		
Ottawa, Ohio, May 19, 1934	1 sp.	R. T. Everly.
Ottawa, Ohio, June 1, 1934	1 sp.	R. T. Everly.

For invaluable service rendered through making available other collections and records of Ohio Carabidae, thus enlarging our knowledge of the distribution of these and of other species, which records in Ohio it is hoped to assemble and present at a later date, acknowledgment is hereby made to the following: Mr. Ralph Dury, Director of the Cincinnati Museum of Natural History; Mr. J. N. Knull, Curator of Insect Collections of the Department of Zoology and Entomology at the Ohio State University; Mr. Harold L. Madison, Director of the Cleveland Museum of Natural History; Dr. August E. Miller, of Zanesville, Ohio; Professor Herbert Osborn, Director of the Ohio Biological Survey; Mr. John C. Pallister, formerly Curator of Insects at the Cleveland Museum of Natural History; Mr. Paul E. Schaefer, of the Department of Zoology and Entomology, Ohio State University; Dr. W. C. Stehr, of the Department of Biology, Ohio University, Athens, Ohio; and Mr. E. S. Thomas, Curator of Natural History, Ohio State Archaeological and Historical Museum, Columbus, Ohio.

Forest Insects

The increased study of forestry and forestry conservation problems has impressed upon many workers the great importance of training the men in these fields of specialization in forest entomology. Many courses in forest entomology have been taught using books on shade tree insects and references to scattered literature as readings for the course. Graham's "Principles of Forest Entomology" (an earlier book on this subject) deals largely with principles, and not a great deal is given on the large number of insects attacking forest or shade trees. The authors of this new textbook have brought together all the important literature on forest entomology into one large volume, and have presented it in the way that the subject is being taught at some of the universities today.

The chapter headings are as follows: Importance of Forest Entomology; Control of Forest Insects, General Considerations; Control of Forest Insects, Bark-Beetle Control; The Control of Insects Injurious to Forest Products; Bark-Beetles and Ambrosia Beetles; The Flat-Headed and Round-Headed Borers; Other Families of Beetles; The Moths and Butterflies; Sawflies, Horntails, Bees, and Ants; Aphids, Scale Insects and Others; Some Other Orders of Insects and the Mites; and Termites or White Ants. At the end of the book is an appendix consisting of the more important hardwood and coniferous trees of the United States and some of their principal insect enemies. The book is well indexed to both common and scientific names. Following each chapter is a list of the more important references which pertain to the particular subject being discussed.

The book is well illustrated, many of the drawings being used for the first time. There seems to be a slight tendency towards the treating of the western insects more thoroughly. Although a very large number of insects are mentioned in the book and the authors are to be complimented for their work, the writer feels that more detailed information on some of the more important insects would have been a valuable addition. The book should serve as a useful text for forest entomology at all forestry schools. It is the most complete text on the subject at the present time.—R. H. Davidson.

Forest Insects, by R. W. Doane, E. C. Van Dyke, W. J. Chamberlin, and H. E. Burke. 463 pp. New York, The McGraw-Hill Book Company, 1936. $4.50.

ILLUSTRATIONS OF EXTERNAL ANATOMY SILPHA AMERICANA LINN. (SILPHIDAE, COLEOPTERA)[1]

NORRIS D. BLACKBURN

This paper on the external features of *Silpha americana* Linn. is offered as a contribution to the knowledge of external anatomy of Coleoptera, and to supply a lack of available material on the external characters of this family. The Silphidae belong to the suborder Polyphaga and the superfamily Staphylinoidea. The primitive type of Polyphaga is found in its original form in the series of Staphylinoidea (Böving and Craighead, 1931).

The nomenclature followed by the writer was adopted from Snodgrass, Singh Pruthi, Crampton, and others.

The writer wishes to express his appreciation to Dr. C. H. Kennedy for the many helpful suggestions and assistance offered during the progress of this work.

GENERAL DESCRIPTION

This species is broadly oval and very flat, being adapted for crawling under objects rather than burrowing as in the case of Necrophorus. The thorax is yellow with a discal black spot. Elytra brownish with elevations much darker. The length of the adult varies from 17–20 mm.

The specimens used in this study were procured from South Bass Island in Lake Erie. Partially decayed meat or dead fish were put into cans which were sunk until the open end was flush with the surface of the ground. These were covered with leaves and examined daily. Often as many as ten individuals of *Silpha americana* were found in some cans. Other Silphidae belonging for the most part to the genus Necrophorus were collected. Several Histeridae were also found.

As material was plentiful dissections were made possible from live beetles. Specimens not used for live dissection were preserved in seventy per cent alcohol. In cases where sutures were difficult to discover the parts were boiled in a ten per cent solution of potassium hydroxide. Drawings were made under binocular using a camera lucida.

THE HEAD

The *head capsule*, from the dorsal view (Fig. 5), appears almost square, is strongly depressed, and can be retracted under the anterior margin of the pronotum until the eyes are almost hidden. Sutures in the head have disappeared or are so faint that they cannot be seen.

[1]Submitted to the Graduate School of Ohio State University in partial fulfillment of the requirements for the degree of Master of Arts.

A depressed area near the inner margin of each eye locates the internal attachments of the dorsal arms of the tentorium. The head is covered with fine pubescence and the region at the posterior margin of the eyes is covered with much longer hairs. The labrum (Lbr) is closely attached to the head capsule, there being no membrane visible externally. The eyes are quite prominent and can be seen from both the dorsal and ventral view. No ocelli are present.

The antennae (Fig. 18), composed of eleven segments and clavate, are inserted behind the base of the mandibles. The third joint is shorter than the second which is one of the key characters separating this species from *Silpha inaequalis* Fab. The segments are gradually clubbed.

The gula is the most prominent part of the ventral view of the head capsule (Fig. 6) and is separated from the gena on either side by the gular suture. It is broad at the anterior median end, narrows suddenly towards the posterior part and at the extreme posterior end broadens where it forms the ventral part of the foramen magnum.

The endoskeleton of the head (Fig. 7) consists of an anterior arm (Ant. Arm), dorsal arm (Dor. Arm), and posterior arm (Post. Arm). The anterior arms project laterally toward the mandibular articulation, and probably serve as muscle attachments for the mouthparts. The dorsal arms project latero-dorsally and fuse with the exoskeleton of the head near the inner margin of the eyes. The posterior arms extend to the lateral margin of the foramen magnum where they are thickened and articulate with the cervical sclerites.

The labrum (Figs. 8 and 9), closely joined to the head capsule, is deeply emarginate at its anterior end and densely covered with setae and fine hairs which are located in the membranous margin. The epipharynx (Epi) lies on the internal surface of the labrum and is covered with fine hairs as far posteriorly as the suture between the clypeus and labrum. Posterior to this suture two sclerotized arms serve as a framework for numerous sclerotized bars which are arched dorsally. These are not shown in the figures.

The mandibles (Figs. 10 and 11) bear on their posterior inner margins a molar area (Mola) covered with transverse ridges which are probably used in the process of chewing food. The anterior ends have one distinct blunt tooth and the tips of the mandibles are modified into a cutting edge. The spines between the mola and the tip are very dense. A membranous area covered with minute setae covers the mola on the dorsal side, the tips of which articulate when the mandibles are closed.

The maxillae (Figs. 12 and 13) are divided into five distinct parts, namely, cardo, stipes, palpifer (Plpfr), galea, and lacinia. The cardo is a rectangular sclerite and bears on its inner margin large condyles which articulate with the head capsule. The stipes is a triangular division anterior to the cardo and contains two sclerites (Crampton, 1923). The palpiger bears on its posterior margin the maxillary palpus which is four segmented, although the first is very small and membranous. The last segment is tipped with tiny granule-like projections which are probably sensory organs. The galea seems to be composed of a single sclerite and is densely covered with brush-like

hairs. The lacinia, attached to the stipes from the dorsal view, bears on its inner surface an area of brush-like hairs and the anterior end terminates in a toothlike structure or blade.

The labium (Figs. 14 and 15) lies on the ventral aspect of the head between the maxillae, and is attached to the head by the mentum and submentum which are usually included as a part of the labium, but strictly speaking are not a part of it (Crampton, 1928). The paraglossae (Pglo) are clearly separated at the anterior margin and are covered with fine setae on the ventral surface. Crampton (1921) calls the true labium the eulabium (which bears the paraglossae, labial stipes and prementum). The central triangular sclerite, the ligula (Lig), is often used synonomously with glossa. It is usually applied to the unpaired median structure projecting between the labial palpi regardless of whether formed by the united glossa alone or whether the paraglossae have entered into its composition (Crampton, 1921). The labial palpi are located on a broad structure known as the palpiger (Plpgr), which is closely joined to the mentum.

The hypopharynx (Hyp, Fig. 16) is a lobe-like structure densely covered with fine hair and supported by heavily sclerotized pharyngeal rods (Phrgl. Rds.) which have small muscle disks on the posterior end. The pharyngeal opening is located at the junction of the hypopharynx and epipharynx.

The submentum (Submtm, Fig. 17) shown in relation to mentum and gula, is attached to the gula by a wide, membranous area. The mentum is oval shaped and is not heavily sclerotized.

THE CERVICAL SCLERITES

The cervical sclerites (Cerv. Scl., Figs. 6, 19, 20) are located on the ventral surface in the membranous area between the head capsule and prothorax. The posterior end of each is broader than the anterior and probable traces of a suture can be found on both posterior and anterior portions. Several small spines project posteriorly from the anterior lateral edge of each sclerite. No attempt has been made to homologize the cervical structures.

THE THORAX

The tergum of the prothorax (Pntm, Figs. 19 and 25) is flattened and nearly twice as broad as long. The pronotum is yellow with the exception of a broad discal black spot. The surface is covered with fine punctures and the lateral margins are thickened and curve slightly upward. A broad emargination at the anterior end overlaps the head while the posterior margin is broadly rounded.

The prosternum (St.–I, Fig. 19) is strongly convex and closely joined to the pronotum which overlaps the suture with a broad margin. No distinct sutures could be found in the prothorax although the outer areas may be pleurites which have become fused with the sternum. These have been labeled Pl–I?. The posterior region of the prosternum bears a median elevation separating the two coxal cavities which are widely open behind. This characteristic of the coxal cavities is one of the distinctions between this genus and *Necrophorus*. The internal view (Fig. 20) shows mainly the muscle attachments (Furca–I).

The mesonotum (Figs. 21 and 22) is occupied largely by the triangular scutellum (Scutel) with which the elytra articulate and under the lateral margins of which they rest, when folded. The praescutum (Praes) is composed of a small phragma which projects downward between the mesothorax and prothorax. The scutum occupies the anterior end of the mesonotum and on either side are two projections which extend anteriorly and downward and are slightly cup-shaped. These probably serve as muscle attachments.

The mesopleuron (Figs. 25, 28 and 29) consists of two sclerites, the episternum (Eps–II), and epimeron (Epm–II) and is figured with the mesosternum and metasternum.

The episternum is roughly rectangular, bearing on its anterior lateral margin the wing processes (Wing Pro.) of the elytron. The inner margin is attached to the mesosternum and the anterior lateral portion to the mesonotum by the axillary sclerites of the mesothoracic wing. There is a small groove at the dorsal junction with the epimeron (Epm–II) in which the anterior lateral edges of the elytra articulate. This can be seen in Fig. 25.

The epimeron is rectangular in shape with the posterior margin broadly rounded. It articulates on its inner margin with the coxa and trochantin of the mesothoracic leg and is separated from the episternum by the pleural suture. It is not connected to the mesonotum at its lateral margin, but loosely covers the metathoracic spiracle (Sp–III), the edge of which can be seen only from the lateral view (Fig. 25). Internally the pleural ridge is very broad and tapers into a pleural arm which is partially fused with a structure similar to the parapterum of the metapleuron. A muscle disk (M. Disk) is located on its inner surface.

The mesosternum (St–II, Figs. 28 and 29), figured with the metasternum and mesopleuron attached, is roughly trapezoidal in shape and the anterior margin serves as an attachment for the intersegmental membranes between the prothorax and mesothorax. The posterior lateral portion extends to the posterior border of the meso-coxal cavities, while the median part joins the metasternum slightly posterior to these. The internal view (Fig. 29) presents a thickened anterior margin to which membranes and muscles are attached. The furcal processes (Furca–II) arising at the posterior margin and anchored to the internal ridge of the metasternum, curve laterally to the pleural ridge of the mesopleuron (Epm–II) and probably serve as an attachment for powerful leg muscles.

The metanotum (Figs. 23 and 24) shows the four typical areas of this division. The praescutum (Praes) is divided from the scutum by the large central membranous area and the two divisions extend laterally almost to the anterior wing processes. These two lateral divisions support the praescutal phragma (A. Ph.) which extends internally towards the center of the body. The scutum is composed of two parts, being divided by the v-shaped ridge separating it from the scutellum. Each half of the scutum is divided into a posterior and anterior region by the internal ridge on the anterior part of the metanotum. The anterior lateral part of the scutum bears the anterior wing processes

(Wing Pros.) with which the first axillary sclerites articulate, and the posterior lateral part the posterior wing processes (Wing Pros.) with which the third axillary sclerite articulates. The axillary cord is attached back of the posterior wing processes.

The postnotum (P. Sctl.) is a long rectangular sclerite lying behind the scutum and scutellum. It is inflexed internally forming the posterior phragma (P. Ph) and serves as an attachment for several muscles and for the membrane which connects the thorax with the abdomen. It articulates with the epimeron (Art. with Epm) at the lateral margins.

The metapleuron (Figs. 25, 26, and 27) is composed of two distinct sclerites. The episternum (Eps–III) is sometimes divided into two regions, the lower division or katepisternum and the anterior division or anepisternum. The posterior division is attached to the metasternum on the inner margin and to the epimeron on the outer edge at the pleural suture (Pl. S.). Its anterior edge is partially fused with the parapterum, on the inner side of which is a large muscle disk (M. Disk) or pronator muscle disk (Snodgrass, 1909). The parapterum and muscle disk border and are closely entwined with the wing processes of the epimeron.

The epimeron (Epm–III) is elongated on its anterior margin to form the wing processes (W. Pro.). Posteriorly it articulates with the postscutellum on its lateral margin and a rectangular extension is bent so that it extends on the dorsal side. This can be seen in Fig. 25. Internally the pleural suture (Pl. S.) becomes the pleural ridge (Pl. Rdg.).

In more generalized insects the epimeron and episternum are arranged crosswise of the body. In the beetles they are apparently shifted so that they are practically parallel with the body walls. The anterior ends are bent so that they form the wing processes (Fig. 25) and the large muscle disk on the internal part suggests that much of the work is done by one large muscle.

The metasternum (St–III, Figs. 28 and 29) is the largest division of the thoracic sterna, occupying the entire area between the hind and middle coxae. It is connected to the episternum at the lateral margins and the posterior part is thickened and serves as an attachment for the abdominal membranes. Internally (Fig. 29) the most conspicuous structure is the large endosternum (End. St.) with the transverse furca (Furca–III) at the anterior end. The median posterior region of the endosternum bears two condyles which articulate with the inner margin of the hind coxae.

The spiracles (Sp–II and Sp–III) of the thorax are shown in Figs. 19 and 25. The mesothoracic spiracles (Sp–II) are located ventrally on the intersegmental membranes between the prothorax and mesothorax and are partially covered by the front coxae. The metathoracic spiracles (Sp–III) are located latero-ventrad near the anterior lateral margin of the mesothoracic epimeron (Epm–II). They are elongate and extend ventrally for over one-half the breadth of the epimeron.

The legs (Figs. 31, 32, and 33) are similar in many respects. The trochantin (Tcn) is found only on the prothoracic and mesothoracic

coxae (Figs. 31 and 32). The prothoracic trochantin possesses a cup-shaped structure on the distal end which articulates with the inflexed area of the pronotum. The front coxae are oblong with very little space between their inner extremities. All the coxae possess a groove into which the femurs fit when folded. The hind femur is longer and broader than the other two and all have a groove on the flexor surfaces into which the tibia fit when folded. The tibia are similar, the hind one being the longest, and all bear several rows of short spurs which project posteriorly. These have not been shown except in the large dorsal view of the whole insect (Fig. 1). All the tarsi are five-jointed and all except the last have brushes underneath and dorsally are covered with numerous hairs not shown in the figures. Two sharply curved claws are present on the last segment.

The metathoracic wings (Fig. 30) are of the Staphylinoidean type of venation, which is distinguished partly by the complete disappearance of the cross veins. The costa (C), subcosta (S), and radius (R) are very close together on the inner basal half of the wing. The median vein is very strong near the tip and has a break midway between the base and distal end, where the wing folds when under the elytron. The cubitals are faint. Two anal veins are present. Possibly the last should be called the third, and the other a fusion of the first and second. No attempt has been made to homologize the axillary sclerites.

The elytra which cover the two thoracic segments and abdomen are brownish with three indistinct costae and numerous cross elevations. They are about as broad conjointly as long and are not fused but open and functional. They articulate with the anterior lateral edge of the mesonotum (Fig. 21) and the wing processes of the episternum (Eps–II, Fig. 29). No attempt has been made to homologize the axillary sclerites which are reduced and very difficult to interpret.

THE ABDOMEN

The tergites (T) of the abdomen (Fig. 3), unlike those of many Coleoptera, are heavily sclerotized with the exception of the first, which is membranous with a distinct longitudinal median line. Eight tergites are visible when the elytra are removed. The second is heavily sclerotized with a wide membranous area separating it from the third. The others when in normal position have no membranous areas exposed, but each overlaps the tergite posterior to it and the fold can be stretched enough to permit freedom of movement of the abdominal segments. The eighth may be invaginated until only the tip is exposed. Two other dorsal sclerites are present and are shown in detail in Figs. 38 and 39 in relation to the genitalia. To homologize these correctly a detailed study of the post-embryonic development should be made similar to the work of Singh Pruthi on *Tenebrio molitor*, 1924. We have labeled these sclerites T–9? and T–10? only as a possible interpretation.

The pleurites are widely separated from the tergites with the exception of the seventh and eighth which are closely joined on the lateral surface.

The sternites (St, Fig. 4) are not separated from the pleurites. The first is membranous except for a small sclerotized area lying under each

hind coxa. All others are heavily sclerotized and covered with small hairs not shown in the figures. Heavy overlapping folds join the sternites in much the same way as the tergites are joined. Two other posterior sclerites are also present which have been designated St–9?.

The spiracles (Sp) of the abdomen (Fig. 3) are eight in number, the first being the largest. It is elongate and broader on its inner margin which is partially covered with an overlapping fold of membrane. The second, third, fourth, and fifth spiracles are located in the membranes near the inner dorsal margins of the pleurites. The sixth, seventh, and eighth are located on small sclerotized areas on the tergites and although very small are still functional.

THE MALE GENITALIA

The terminology of Sharp and Muir (1912) is followed in interpreting the male genitalia. These are probably more concerned with internal anatomy but since they are so heavily sclerotized they have been considered as falling in the scope of this study.

The male genitalia (Figs. 38, 39, 40, 41, 42, and 43) are composed of three main sclerotized divisions, namely, the lateral lobes (Lat. Lobes), the median lobe (Med. Lobe), and the basal piece (BP).

The median lobe, which is practically cylindrical and sclerotized on the ventral surface but membranous on the dorsal side, encloses the ejaculatory duct (Ej. Duct), which may be extruded from the median orifice (Med. Or.) located on the dorsal tip. The lateral lobes, situated on either side of the median lobe, are sclerotized on their outer lateral margins and membranous interiorly next to the median lobe. The elongate basal piece is a heavily sclerotized rim with internal membrane. The anterior portion viewed laterally (Fig. 43) is thicker than the posterior part. Ventral to the basal piece there is a y-shaped supporting structure, the spiculum (Spi, Figs. 38, 39, 40), which probably aids in the movement of the genitalia. It is cup-shaped at the anterior end and fits over the basal piece while the posterior ends are attached in the membranous area anterior to the sclerite labeled St–9?.

The ejaculatory duct (Ej. Duct) enters the median lobe ventral to the basal piece and ends at the median orifice (Med. Or.). The internal sac (Int. Sac) is very prominent and projects anteriorly over the edge of the basal piece. A thin membrane which is attached at the base of the lateral lobes forms the genital pocket (Singh Pruthi, 1924). The anus is dorsal to the genital opening and is shown in Fig. 38 only by dots as it lies under the dorsal plate marked T–10?.

THE FEMALE GENITALIA

The female genitalia are shown in Figs. 44–48. In view of the fact that our data is furnished by the sclerotized parts only, we have used the terms applied by Tanner (Genitalia of Female Coleoptera, 1927). In using these we do not argue that they are the correct interpretations of homologies. The homologies of genital parts of beetles will not be known until work of a different type has been done. Apparently three lines of study will eventually solve the problem of the homologies of these parts, namely, (1) studies such as that of Tanner on the com-

parative anatomy of the sclerotized parts of beetles, of Walker on Orthopteroid insects, and of Crampton on insects in general; (2) studies on post-embryology such as made by Muir and Singh Pruthi, and (3) studies of the musculature of parts as made by Snodgrass, Weber and Norma Ford. Thus we are not positive of the parts labeled paraprocts, proctiger, and valvifer, but use these parts only as labels. The anus is dorsal to the genital opening.

SECONDARY SEX CHARACTERS

In size there is no constant noticeable difference between male and female. However, the angle at the tip of the elytron of the female (Fig. 35) is much more acute than in the male (Fig. 34). The front tarsi of the male (Fig. 36) are dilated much more decidedly than those of the female (Fig. 37). No differences could be found in the antennae.

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EXPLANATION OF PLATES

Plate I

Fig. 1. Dorsal view of *Silpha americana.*
Fig. 2. Ventral view of *Silpha americana.*
Fig. 3. Dorsal view of abdomen.
Fig. 4. Ventral view of abdomen.
Fig. 5. Dorsal view of head capsule.
Fig. 6. Ventral view of head capsule.
Fig. 7. Endoskeleton of head capsule.

Plate II

Fig. 8. Internal view of labrum showing epipharynx.
Fig. 9. External view of labrum with clypeus removed, showing internal sclerotized rods.
Fig. 10. Dorsal view of left mandible.
Fig. 11. Ventral view of left mandible.
Fig. 12. Dorsal view of left maxillary.
Fig. 13. Ventral view of left maxillary.
Fig. 14. External view of labium.
Fig. 15. External view of labium, mentum and submentum removed, showing pharyngeal rods.
Fig. 16. Internal view of labium showing hypopharynx.
Fig. 17. External view of mentum, submentum, and gula.
Fig. 18. Antenna.

Plate III

Fig. 19. External view of prothorax.
Fig. 20. Internal view of prothorax.
Fig. 21. External view of mesonotum with elytron attached.
Fig. 22. Internal view of mesonotum.
Fig. 23. External view of metanotum.
Fig. 24. Internal view of metanotum.
Fig. 25. Lateral view of thorax.
Fig. 26. External view of metapleuron.
Fig. 27. Internal view of metapleuron.

Plate IV

Fig. 28. External view of mesosternum and metasternum with mesopleuron attached.
Fig. 29. Internal view of mesosternum and metasternum with mesopleuron attached.
Fig. 30. Metathoracic wing.
Fig. 31. Prothoracic leg.
Fig. 32. Mesothoracic leg.
Fig. 33. Metathoracic leg.
Fig. 34. Tip of male elytron.
Fig. 35. Tip of female elytron.
Fig. 36. Front tarsus of male.
Fig. 37. Front tarsus of female.

Plate V

Fig. 38. Dorsal view of male genital segments with genitalia in place.
Fig. 39. Ventral view of male genital segments with genitalia in position.
Fig. 40. Lateral view of male genital segments.
Fig. 41. Dorsal view of male genitalia.
Fig. 42. Ventral view of male genitalia.
Fig. 43. Lateral view of male genitalia.
Fig. 44. Dorsal view of female genital segments.
Fig. 45. Ventral view of female genitalia.
Fig. 46. Dorsal view of coxite and stylus, (valvifer removed from right hand figure).
Fig. 47. Ventral view of coxite and stylus, (valvifer removed from left hand figure).
Fig. 48. Lateral view of female genital segments.

ABBREVIATIONS USED ON FIGURES

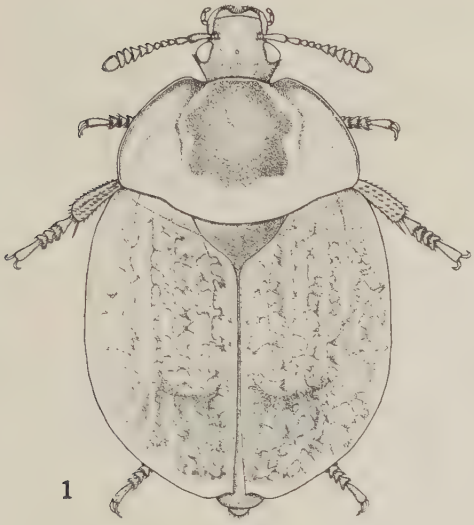
A, anal vein.
A. Ph., anterior phragma.
Ant. Arm, anterior arm of the tentorium.
Art. with Epm., articulation with the epimeron.
Ax. C., axillary cord.
BP, basal piece.
C, costa.
Cerv. Scl., cervical sclerites.
Clyp, clypeus.
Co, coxite.
Cu, cubitus.
Cx, coxa.
Dor. Arm, dorsal arm of the tentorium.
Ej. Duct, ejaculatory duct.
End. St., endosternum.
Epi, epipharynx.
Epm, epimeron.
Eps, episternum.
Gen. Op., genital opening.
Hyp, hypopharynx.
Int. Sac, internal sac.
Lat. Lobes, lateral lobes.
Lbr, labrum.
Lig, ligula.
M, median veins.
M. Disk, muscle disk.
Med. Lobe, median lobe.
Med. Or., median orifice.
Mtm, mentum.
Par, parapterum.
Pglo, paraglossa.
Phrgl. Rods, pharyngeal rods.
Pl, pleurite.
Pl. Rdg., pleural ridge.
Pl. S., pleural suture.
Plpfr, palpifer.
Plpgr, palpiger.
Pntm, pronotum.
Post. Arm, posterior arm of the tentorium.
Ppr, paraproct.
P. Ph., posterior phragma.
Praes, praescutum.
Proct, proctiger.
P. Sctl., postscutellum.
R, radius.
Sc, subcosta.
Scutel, scutellum.
Sp, spiracle.
Spi, spiculum.
St, sternite.
Sty, stylus.
Submtm, submentum.
T, tergite.
Tcn, trochantin.
Vf, valvifer.
Wing Pro., wing process of meso- and metapleuron.
Wing Pros., anterior and posterior notal wing processes.

NUMBERING

Roman numerals I, II, and III, refer to the prothorax, mesothorax, and metathorax respectively. Numerals 1–10 designate first to tenth abdominal segments.

Silpha americana
Norris D. Blackburn

PLATE I



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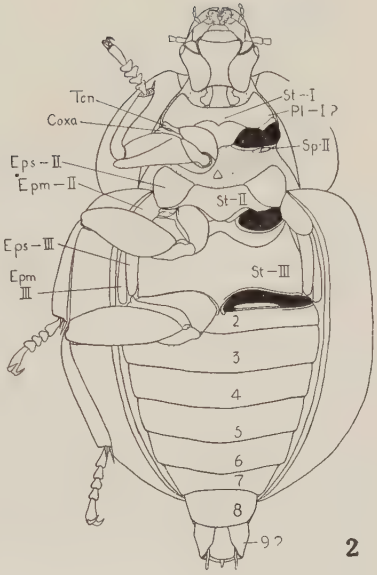

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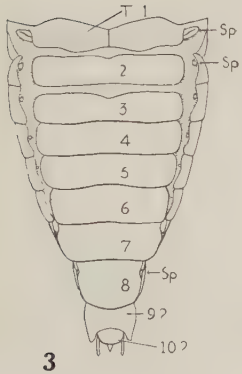

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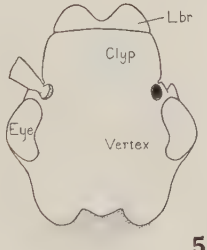

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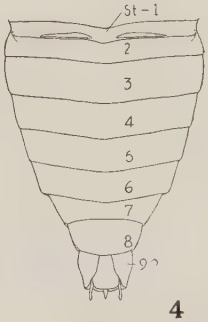

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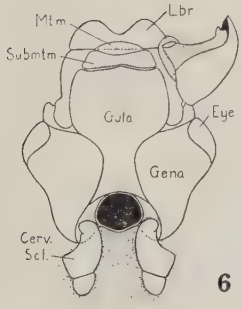

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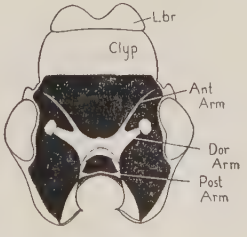

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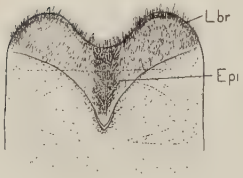

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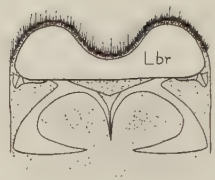

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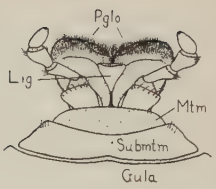

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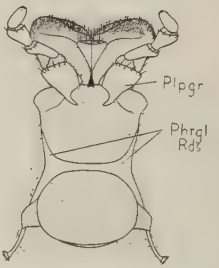

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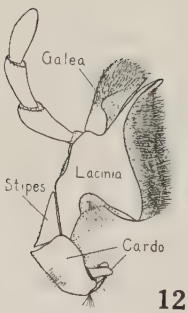

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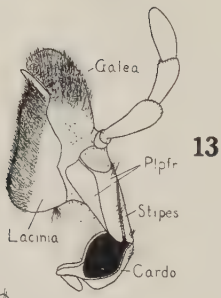

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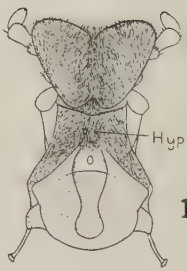

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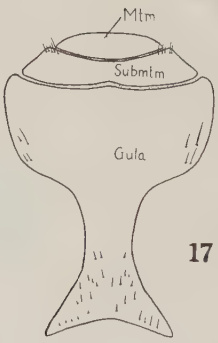

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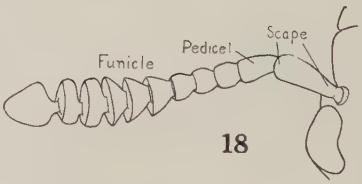

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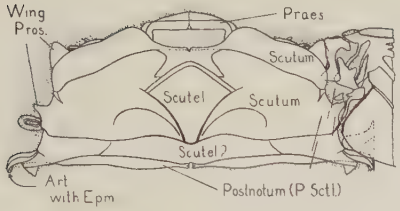
Silpha americana
Norris B. Blackburn

PLATE III



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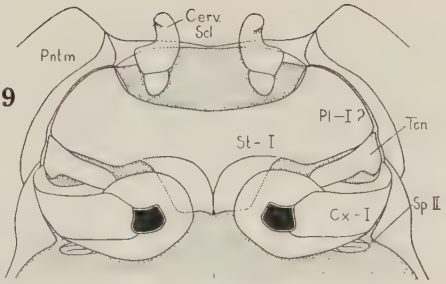

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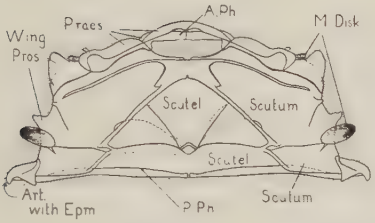

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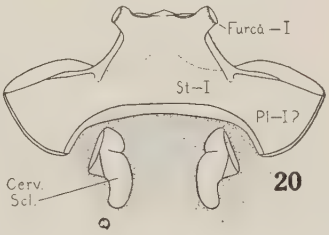

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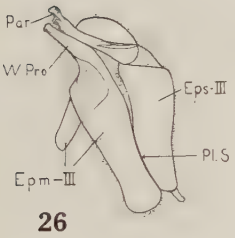

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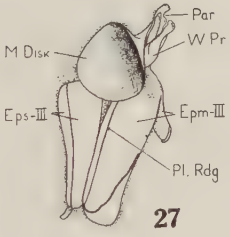

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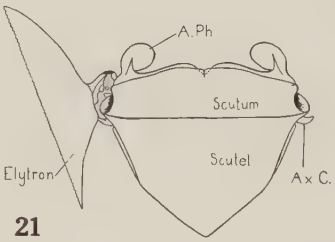

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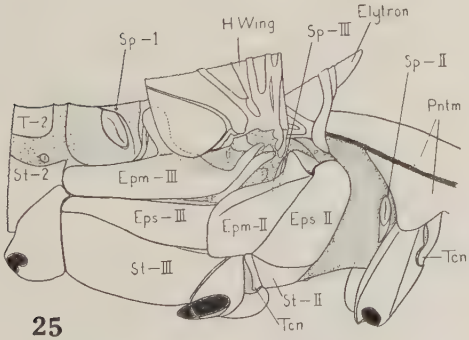

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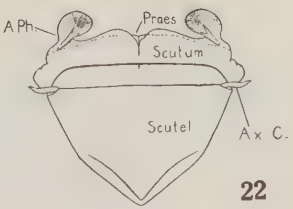

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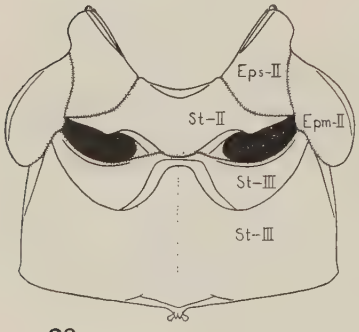

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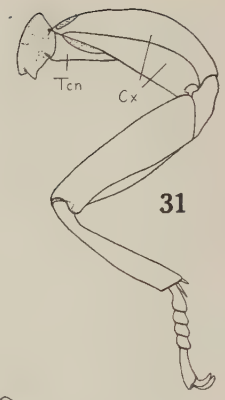

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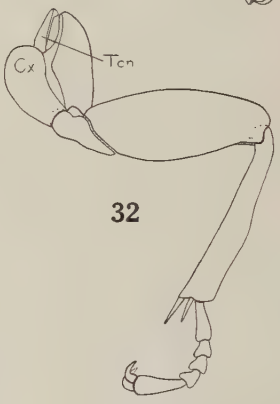

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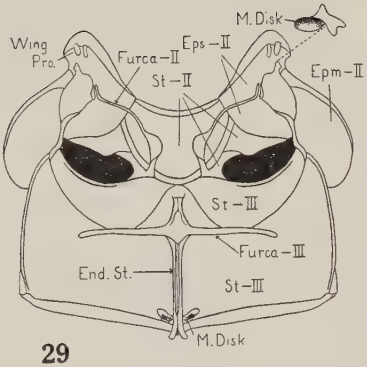

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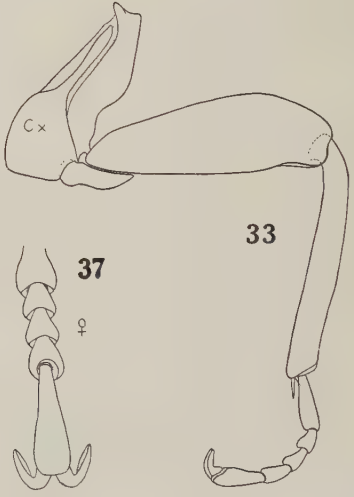

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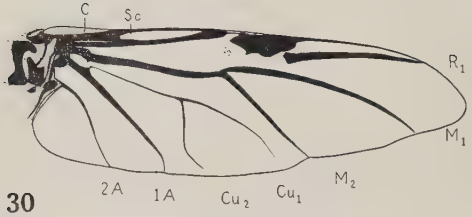

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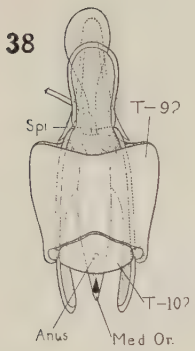
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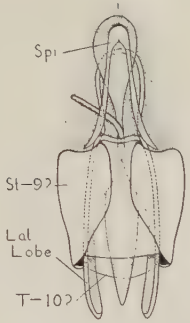
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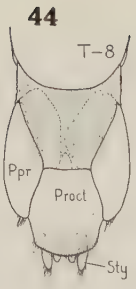
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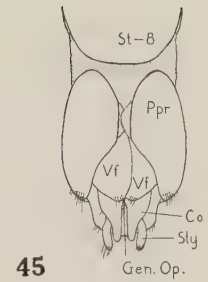
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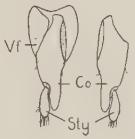
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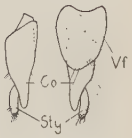
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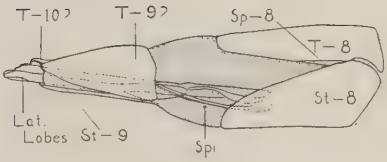
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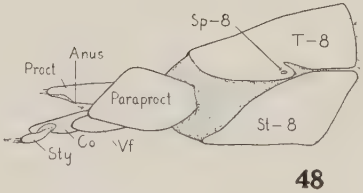
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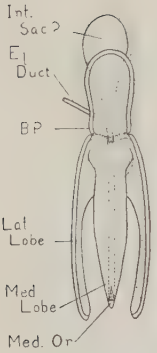
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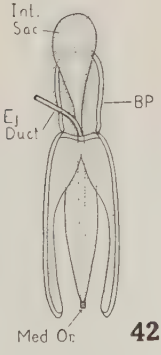
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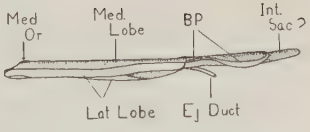
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BOOK NOTICES

Cells and Tissues

A clear, forceful style, terse, pithy sentences, and short, compact chapters characterize this excellent introduction to histology. While valuable to the medical student, the applications of the book do not end there. The author has kept in mind the interrelations of a knowledge of cells, tissues, endocrine glands and other organs with the broader aspects of genetics, evolution, physiology and the social sciences. Each tissue, organ and system is thoroughly though briefly discussed. Especially good are the chapters on blood, marrow, and the endrocine glands. As here presented, the subject matter of histology becomes an integral and essential part of biological knowledge and culture. Students of biology in any of its phases will enjoy and profit by this volume.—L. H. S.

A Textbook of Histology, by Joseph Krafka, Jr. vii+246 pp. Baltimore, The Williams and Wilkins Co., 1936. $2.50.

The Great Naturalists

This is a series of historical essays, delightfully written and attractively printed and bound. From the classic scholars of Greece and Rome to the modern observers and students of nature, the great naturalists of history pass before us. We catch intimate glimpses of their work and their inspiration, their hopes and fears, their failures and successes, and above all, their love of nature and the living world. We find ourselves inexorably caught in the spirit of the book, and born buoyantly on the current of outdoor investigations. From Aristotle through Baubin, Gesner and Rondelet, Malpighi, Swammerdam and Leauwenhoek, Buffon and Reaumur, Linnaeus and Artedi, Cuvier and Lamark, Bartram and Michaux, Wilson and Audubon, Say and Rafinesque, Goethe and the Romanticists, Darwin and Wallace to Fabre, the spirit of research in natural history permeates and gives life to the book. For those who know the peace and the turbulence, the satisfaction and the despair of research in the field, the volume is highly recommended. For those who have not this knowledge, a reading of this book is not only recommended, but strongly urged.—L. H. S.

Green Laurels, by Donald Culross Peattie. xxiii+368 pp. New York, Simon and Schuster, 1936. $3.75.

Biometry

"An Outline of Biometric Analysis," by Alan E. Treloar, in its 1936, second edition, covers the fundamentals of statistical procedure in a practical and progressive manner. Of special importance is the clarity of the text, wherein lies its appeal to the non-mathematical research worker or student.

The outline is divided into three parts, each of which is designed to form the basis of a term of college work, or the whole when supplemented with practical or laboratory problems should form a sequence for progressive work for the school year. The first part introduces statistical measurements in univariate and bivariate frequencies, some uses of the chi square test, and the significance of differences in means. The second part deals with the correlation ratio, contingency, partial correlation and intra-class correlation. The third part elaborates the techniques of the "small sample" and the elements of "analysis of variance."

In this outline we have a sound contribution to a field that has too long remained obscure, not because of innate difficulty, but rather for lack of clear presentation of fundamentals. The research worker or student wishing to develop confidence in statistical usages will find this outline a valuable aid, for the algebraic derivations necessary for routine applications are carefully worked out, and interpretation of results in terms of probability is stressed in each section of the outline.—R. G. SCHOTT.

An Outline of Biometric Analysis, by Alan E. Treloar. 193 pp., mimeoprint. Minneapolis, Burgess Publishing Co., 1936. $3.10.

The Psychology of Education

Twenty-five psychologists and educators from twenty-two colleges and universities have collaborated to produce this volume. Although each chapter is by a different author, the continuity is excellent and the arrangement logical and functional. Among the topics treated are growth, acquisition of skills and knowledge, attitudes, problem solving, creative activity, motivation, character and personality, learning, individual differences, nature and measurement of intelligence, educational measurements, teacher evaluation and guidance. The genetic viewpoint is clearly kept in mind, and the co-operative role of genetic and environmental influences in the production of characteristics is recognized and stressed throughout the book. It is indeed a pleasure to find the biological basis of behavior so clearly perceived and used in the treatment of a subject which all too often lacks the biological approach.—L. H. S.

Educational Psychology, by twenty-five collaborators, edited by C. E. Skinner. xxvi+754 pp. New York, Prentice-Hall, Inc., 1936. $3.20.

Radiation

The development of the quantum mechanics which has made it possible to make quantitative theoretical predictions concerning atomic and molecular phenomena has had its most evident successes in the application to actual atomic and molecular mechanical problems rather than in theory of radiation. This field which deals not only with such items as, for example, the shapes and breadths of spectral lines, dispersion, etc., but also is fundamental in the study of cosmic rays and other nuclear phenomena, is one of ever increasing importance in modern physics. It is therefore with enthusiasm that we receive this book, The Quantum Theory of Radiation, the first of its kind to systematically present an account of this theory. Beginning with a discussion of the classical theory of radiation, such subjects as field theory, the interaction of radiation with matter, radiation processes connected with the positive electron and the penetrating power of high energy radiation is discussed in the quantum theory. This work can be heartily recommended as one which deserves a place among the other books on the physicist's shelf.—H. H. Nielson.

The Quantum Theory of Radiation, by W. Heitler. xi+252 pp. Oxford, at the Clarendon Press, 1936. $6.00.

How to Know the Insects

This book was prepared by the author with special reference to the insects of Iowa, but should have a rather wide application because many of the species found in Iowa are also common throughout the Mid-west. The material presented by the author is as follows: the place of insects in the world; the development of insects; directions for collecting and mounting insects, including a list of 65 places to look for insects; how to use an identification key; an illustrated key for the identification of the more common families of insects; the Iowa insect survey; a list of the Orders and Families of insects with a common example for each family and a note on where they can be found; and a combined index and glossary of important terms.

Under the topic of collecting and mounting the author gives types of nets, ways of making nets, making killing bottles, use of baits, traps, and the making of light traps. Methods of pinning, spreading, various types of mounts, and the labelling of insects are discussed rather thoroughly. The illustrated key has one common representative of each family figured and briefly described. This should be valuable especially to a beginner in entomology.

The book is planographed by the John S. Swift Company and may be obtained with either side staple binding or spiral binding. The book should be useful to the high school biology teacher as well as to college students who are being exposed to their first taxonomic studies in entomology.—R. H. Davidson.

How to Know the Insects, by H. E. Jaques. 140 pages, 251 figures. St. Louis, The John S. Swift Co., Inc., 1936. $1.00. (Twenty-five per cent discount on orders of 10 copies or more. The book may also be obtained from the author at 709 N. Main Street, Mt. Pleasant, Iowa.)

Biology

This book is a general introduction to biology. It should prove particularly useful to that group of students who do not continue in either botany or zoology. The major portion of the book consists of a study of the physiological processes of selected type forms, both plant and animal. No attempt is made at completeness from the standpoint either of systematic zoology and botany or of biological theories. There is very little said concerning ecology, parasitology or economic importance. Emphasis is placed upon unity of life processes. What is an animal, and how does it live? What is a plant, and how does it live? How do animals and plants differ? These three questions are discussed in this book. The section on heredity is clear and understandable, presenting the basic principles of this phase of biology. Dr. Rice's discussion of evolution is especially well organized and leads one gently but firmly to a rational conclusion. The book is well illustrated, the type large and clear, paper and binding are of good quality.—J. A. MILLER.

An Introduction to Biology, by Edward Loranus Rice. xii+602 pp. Boston, Ginn and Company, 1935.

Biological Effects of Radiation

Biologists and physicists alike have prospected the ever-broadening field which links their sciences with results which have often been no contribution to either. This two volume work, sponsored by the National Research Council, should aid in bridging this gap, and help investigators to tread more securely as they approach many of the problems of biophysics. Forty-six authors have collaborated in the preparation of the forty-three papers which are included. Each of the authors is a well known investigator in the field concerning which he has written. The editor-in-chief has guided the compilation of this material with the assistance of six collaborating editors.

Papers I–V, inclusive, and VII deal with the fundamental aspects of radiant energy phenomena and should prove of interest to all biologists. They are readily comprehensible to any reader with an elementary knowledge of physics and admirably epitomize the present status of physical knowledge and theory in the field of radiations. The papers on "Photons and electrons" (Darrow) and "Measurement and application of visible and near-visible radiation" (Brackett) especially should attract widespread attention.

Each of the remaining thirty-six papers deals with a specialized phase of the effects of radiant energy upon living organisms. Few aspects of the subject have escaped consideration. Not all of these contributions will be of interest to any one biologist, but every biologist should find at least a few of them to more than repay him for the time required for their reading. Plant science is better represented than animal science, twenty of the papers dealing primarily with influences of radiation upon plants. This distribution of the topics discussed reflects primarily the greater attention which botanists have devoted to radiant energy effects than zoologists.

Without prejudice to the other contributions, all of which appear to be meritorious, the following may be mentioned as most likely to be of interest to biologists generally: "Radiation and the vitamins" (Bills), "Motor responses to light in the invertebrate animals" (Mast), "Action of radiations on living protoplasm" (Heilbrunn and Mazia), "Photoperiodism" (Garner), "Light Factor in photosynthesis" (Spoehr and Smith), "Effects of radiation on bacteria" (Duggar), and the series of five papers by Dobzhansky, Schultz, Stadler, Goodspeed, and Anderson upon chromosomal aberrations and mutations as induced by radiations. The dispassionate review by Hollaender of the status of the problem of mitogenetic rays is a welcome contribution to this highly controversial subject.

Most of the papers are copiously and excellently illustrated, many of the fundamental relations being graphically presented. Practically every paper includes a selected bibliography, many of which are extensive. The value of these is self-evident. It is a book to which any alert biologist will be able to turn again and again with profit.—B. S. MEYER.

Biological Effects of Radiation. Edited by B. M. Duggar. Two vol., 1,342 pp. New York, The McGraw-Hill Book Co., 1936.

Mining

The subject of mine economics has been little touched upon by the mine engineer and geologist and hence it is with pleasure that this book comes to hand. It is divided into three parts: Mine Valuation, Mine Organization, and Mine Management. Under Mine Valuation, Prof. Hoover goes into great detail as to how to correctly evaluate a mine from the sampling to the final report. All persons having to make either engineering or geologic reports should read this chapter on "reporting." In the section on mine organization are considered the set-up of mining companies, promotion, the stock exchange and a series of interesting descriptions of things to beware of under the heading "Fakes and Fallacies." Many good warnings often unheeded by the investing public are included here. An all-too-brief but with-all very good chapter on the Mining Engineer and the Law finishes Part II. In Part III (Mine Management) we are concerned with the organization and duties of the mine staff from the manager down. This section also considers the training and discipline of mine personnel, and their safety, health, and welfare. The last chapter discusses the young engineer and his career. Here is much good advice for the young graduate.

This is a most valuable book and although directed primarily at mine engineering, it would also apply to petroleum engineering and other phases of economic geology. It can be recommended for all students of geology even though they do not expect to be engineers. Most if not all geologists at one time or another are connected with economic problems and would find this volume very valuable. Investors in the mining industry would also find it of value as would some boards of directors and others having to do with the employing of geologists. Much misunderstanding might be avoided if the facts included in this volume were more commonly known. The book is well organized and well written. Rather complete bibliographies with each chapter are very useful as is the carefully worked out and complete index.—WILLARD BERRY.

The Economics of Mining (Non-ferrous Metals), by T. J. Hoover. viii+547 pages. Stanford University Press, 1933. $6.00.

Elementary Geology

There is now available a book of some 500 pages divided into fifty-one chapters which covers in an interesting and non-technical manner the field of general geology. The first thirty chapters cover what is usually termed physical geology and the last twenty cover historical geology. Numerous figures, some more or less humerous but in general to the point, are scattered through the text. Some of them we fear are somewhat too jocular and are likely to instill the wrong impression in the student's mind. We refer to the cephalopoda with arms and legs, using dumbbells and other such pictures. There are in addition to text figures 64 pages of rotogravure pictures in four groups. These illustrations are excellent and as far as we know a new step in geologic texts. It is to be regretted that the titles of the pictures do not clearly indicate the scenes to which they refer. Another criticism is that pictures on widely different scales are shown on the same page with no reference to the exact size. For example, on Plate 61 a picture entitled "Large fishtail drills" shows in part several fish tail drills and just below is a "Gusher in a Crane Field." The largest "fishtail" is three inches high and the "gusher" only about two inches. Some scale should have been introduced. This is one of the University of Chicago "New Plan" texts and as such is to be used in the geological program for the physical science general course. As part of a general course in physical science it may serve satisfactorily. For a full term college course it would appear to be entirely too elementary and rather difficult to teach. The arrangement seems awkward and although we do not ask for any set order the one followed here does not seem to intergrate with any laboratory set-up. After all, geology is a laboratory science. Although we would not care to use it as a text we have had students who would have benefited by reading it.

The make-up is excellent. It is printed in clear type on non-calendared paper, making for easy reading. The use of rotogravure pictures gives excellent reproduction.—WILLARD BERRY.

Down to Earth, by Croneis and Krumbein. xviii+501 pages. Chicago, University of Chicago Press, 1936.

Structural Geology

During the past five years there has been quite an advance in structural geology. Nevin in the second edition of his text on structural geology follows the same method of treatment as in the former edition. The text is divided into twelve chapters; it begins with the physical properties of rocks and ends with mountain systems. A chapter on "Structures associated with Igneous Intrusions" is by E. B. Mayo and is an addition to this edition. Various phases of structural geology are taken up from several different viewpoints. This is especially true of the more disputed parts of the field. The chapter on "Some Facts, Inferences and Hypotheses Regarding the Earth-- gives an excellent picture of what we know and what we infer. The discussion of isostasy and continental drift is well handled. It is presented so as to present the several sides of the arguments, allowing the student to realize that all is not finished. The references, although primarily from American sources, are such that the more advanced students will find leads into the detailed literature. The discussions are in general simple and clear. Some of the terms used such as high-angle and low-angle faults, seem to us to be poor usage. The use of foot-notes and of numbered references as well is confusing.

This text should prove even more popular than the first edition. It is well written and quite readable. The illustrations are good. It is a beginning text and makes no pretense to be otherwise. Needless to say the make-up and typography are in the usual style of the publishers.—WILLARD BERRY.

Principles of Structural Geology, by C. M. Nevin. xii+348 pp. New York, John Wiley and Sons, 1936.

Mineralogy

For those familiar with the second edition of this work we need only quote from the Preface of the third edition: "Changes have been made in the chapters of Physical Properties, the Polarizing Microscope, Crystal Structure and X-ray Analysis, and the Formation and Occurrence of Minerals. . . . Sixty-six illustrations have been added, and the number of pages has been increased by thirty-four." For those not familiar with this text we find it divided into 18 chapters: crystallography, the six crystal systems, compound crystals, physical properties, the polarizing microscope, crystal structure and X-ray, chemical properties, formation and occurrence of minerals, qualitative blow-pipe methods, descriptive mineralogy, gems and precious stones, and classification of minerals according to elements. This takes up 438 pages. A glossary of 222 terms comprises 6 pages. A tabular classification showing elements of symmetry and the simple forms of the 32 classes of crystals takes 7 pages. The rest of the text is devoted to tables for the determination of the 150 minerals described. These tables are based first upon the color and luster of the mineral, then upon the streak, finally upon increasing hardness. When these are run down the other physical properties are used to completely identify the mineral. Brief descriptions of the minerals are given in the tables. A rather full index completes the book.

This is definitely a text for introductory mineralogy of college level, and as such it is excellent. We question the advisability of including so much on X-ray analysis in a text of this rank. The illustrations of the minerals and crystals are excellent and clear. The inclusion of pictures of important mineralogists has our hearty approval. Such pictures add much to the interest of the beginner and help all of us to remember how some of our friends looked. A few of the rock-type figures do not give clear ideas of the rock texture. We refer especially to figures 4 and 5; either figure might be titled the opposite of what it is. However, we will admit that it is nearly impossible to take pictures of marble and sandstone of about the same grain size and reduce the picture and still show any great difference. This text is very well suited for general introductory mineralogy where the number of minerals to be studied is within the 150 described. The make-up and handling are in the usual excellent style of the publishers.—WILLARD BERRY.

Mineralogy, An Introduction to the Study of Minerals and Crystals, by E. H. Kraus, W. F. Hunt, and L. S. Ramsdell. Third edition, x+638 pp. New York, The McGraw-Hill Book Co., 1936.

One Man's Idea of Physical Science

Sir Arthur Eddington believes that the world of physical science with all its apparent complexity is not so strange as the human mind which has assigned to it this complexity. The world picture is, in short, the result of the reaction of man's consciousness with it, rather than a picture having an inherent truth apart from that consciousness. Eddington has already had a good deal to say concerning this viewpoint in "The Nature of the Physical World" and "The Expanding Universe." In the present book, "New Pathways in Science," he adequately discusses contemporary developments in physical science again from the same point of view. Many who are convinced that real electrons swoop dizzily around real nuclei in real orbits will probably not agree with Sir Arthur, but in the opinion of the reviewer his is much the soundest way of looking at the problems of physical science.

"New Pathways in Science" integrates current ideas in physics, astronomy and philosophy. There are chapters on the Decline of Determinism, Indeterminacy (one of the very few adequate treatments that has yet been written on this subject), Probability, Constitution of the Stars, Subatomic Energy, Expanding Universe, and the Theory of Groups. All these are written in Eddington's engaging but minutely penetrating style.

The book is one that should be read by everyone having a mature interest in physical science whether they agree with this one man's idea of the universe or not.—C. HESTHAL.

New Pathways in Science, by Sir Arthur Eddington. x+333 pp. New York, The Macmillan Co., 1936.

Statistical Methods

In this revised edition we have almost a new book. Symbols and formulae are brought into standard form, and new and specialized techniques are given a place. Perhaps most important is the assemblage of tables useful in statistical calculations and determination of significance. Among the tables, besides those given as computation aids, squares, cubes, etc., are values of the probability integral, a table of odds, ordinates of the normal curve, Chi square, tables of F for ratio of variances, t for significance of mean differences, and significance and values for r in several combinations and functions. Tables for use in the study of human inheritance give values of Q for various sized families and various cross-over values, and the standard error of Q (Wiener). Tabulated proportions of expected recessives in random matings of dominants, R and S classes, (Snyder), are also included. The book fulfills its conception as a manual for the worker confronted with the need for reference forms, however it is by no means exhaustive in the applications of any particular technique. The exposition is crisp and concise and each method of procedure is illustrated with problem material so that a novice in statistics should be able to follow the technique. The student of statistics will notice the lack of algebraic derivation that give formulae relationships. But as a manual for definition of working forms one is gratified to find so much practical and fundamental material assembled in a small convenient volume.

—R. G. SCHOTT.

Statistical Methods in Biology, Medicine and Psychology (4th Edition), by C. B. Davenport and Merile P. Ekas. xii+216 pp. New York, John Wiley and Sons, Inc., 1936.

How Animals Develop

To understand how animals develop is to know what they are. Our present knowledge, however, is a polychrome mosaic, black in many places, but being filled in with blocks from many sources. The beginning student of embryology finds himself hopelessly confused in the task of tracing both the pathway of development, from ovum to adult, and the interplay of forces which determine it. Numerous descriptive studies trace in detail development as observed from sections and reconstructions. But what of the rapidly growing literature dealing with micromanipulations and analyses, with artificial parthenogenesis, the role of vitamins and hormones, the function of the newly-discovered organizers, and the interaction of genes and cytoplasm? What is the significance of mutilation experi-

ments, of transplantations, of vital staining and tissue culture? Where do axial gradients come in, and do we still retain Haeckel's law of Recapitulation?

A simple, clear statement is indeed needed and welcome. Professor Waddington has attempted to give just such an exposition. He has brought these questions together and shown their interrelationships in a way not otherwise understood by the student without a very wide range of reading and thought. Writing in relatively simple but precise language, the author, I think, will make himself clearly understandable to the beginning student in embryology, and stimulate him to read further. Many questions are raised; a few are answered.

This volume does not constitute a source book in any sense. Its main usefulness is probably in orienting and stimulating the student. The author's hope of writing intelligibly for the interested layman is doubtfully realized. However, the difficulty lies more in the inherent complexity of the subject and the prerequisite of a broad reading knowledge in Biology.—JOHN W. PRICE.

How Animals Develop, by C. H. Waddington. 128 pp. New York, W. W. Norton & Co., 1936.

Physical Chemistry

This new work departs rather widely from the traditional formula for a physical chemistry textbook. The author places great emphasis upon the state of equilibrium in a chemical reaction and the rate at which the equilibrium is attained. The book is written around these two fundamental chemical problems. Consequently the arrangement of material differs from that of most other works in the field. There are no single chapters on the liquid state or the solid state, material on these states being distributed through the book under the various general headings. Certain fundamental propositions are discussed at length, such as the laws of thermodynamics and the theory of Debye and Huckel. Some subjects usually included in elementary texts are omitted; there is no discussion of the colloidal state.

The treatment is unusually mathematical for a beginners' textbook, and is designed for students with a knowledge of calculus. Detailed explanations usually accompany and clarify the calculations. The excellent chapter on the quantum theory is for the mathematically inclined reader only.—HERMAN VON DACH.

Elementary Principles in Physical Chemistry, with special reference to the state of equilibrium in a chemical reaction and to the rate of attainment of the state of equilibrium; by T. J. Webb. x+344 pp. New York, D. Appleton-Century Company, 1936.

Earthquakes

Earthquakes—such a title brings to mind the scare heads of the newspapers telling of the damage, the loss of life, and so on accompanying the scattered major earthquakes, but usually does not bring to mind the detailed and careful studies carried on by students of earthquakes and of the earth's interior. Dr. Heck has put into some 218 pages a rather exact account of the what and the way, as far as known, of earthquakes. In a relatively non-technical manner he has given us a general review of some of the progress of seismology. The first nine chapters deal with the effects, causes and studies of earthquakes coupled with their recording and interpretation. The seismic belts of the earth are discussed in chapter ten, while the next chapter discusses some seventeen of the world's great earthquakes. The earthquake regions of the United States are handled in chapter eleven and the next two chapters consider regional investigations. The human side with safe construction is not forgotten. An answered questionnaire of some 23 factorial questions makes up chapter sixteen. A brief history of Seismology closes this very useful book.

The book is written in a non-technical style, and although somewhat meaty is nevertheless good reading. The numerous pictures, diagrams, and charts are well selected and add much to the text. We feel that Dr. Heck has given us a book which should fill an important place as a general reference for students in geology and related fields. It is not a text, but a general book.—WILLARD BERRY.

Earthquakes, by Nicholas Hunter Heck. xi+222 pp., Princeton University Press, 1936. $3.50.